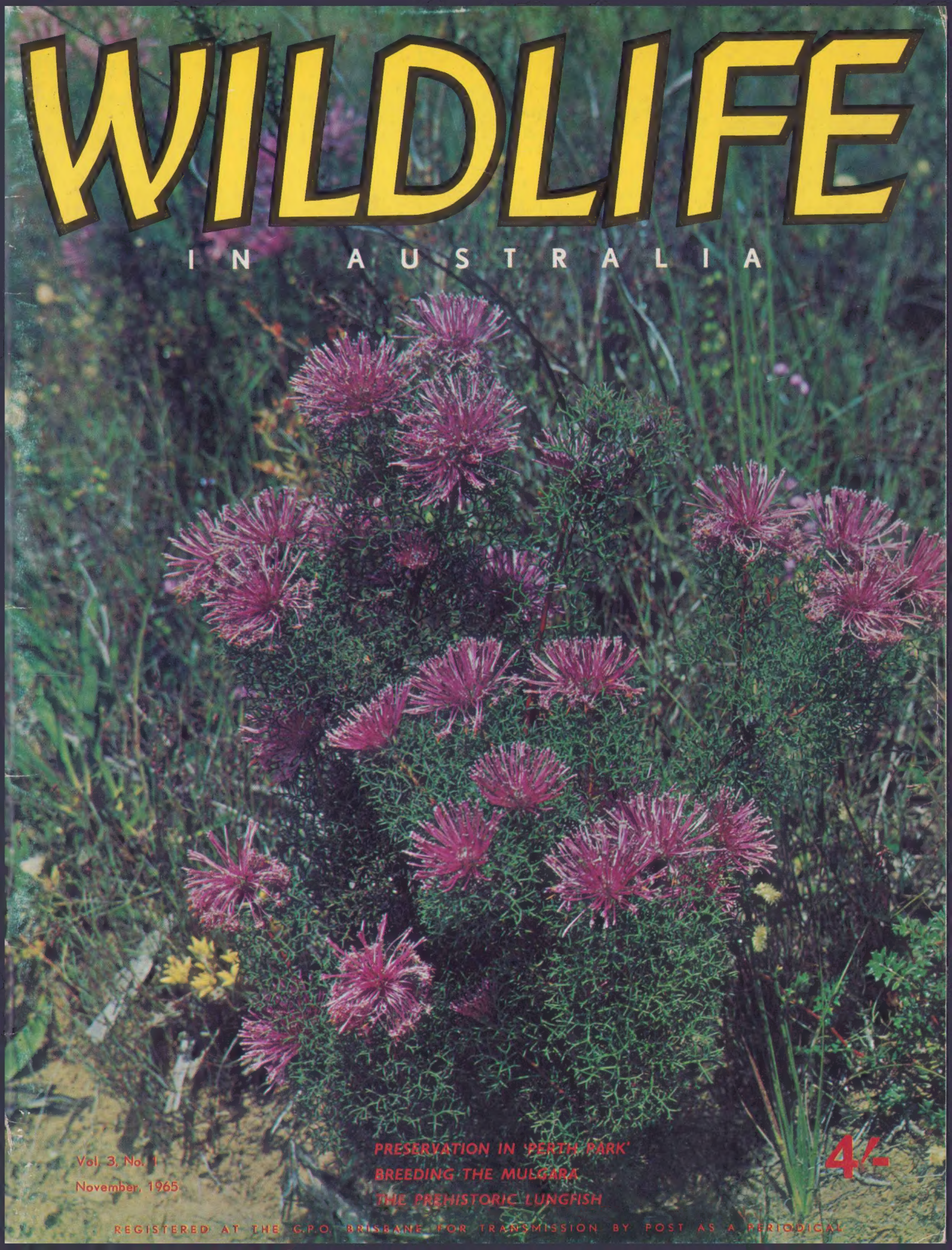
WILDLIFE

IN AUSTRALIA



PRESERVATION IN 'PERTH PARK'

BREEDING THE MULGARA

THE PREHISTORIC LUNGFISH

Vol. 3, No. 1

November, 1965

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THE COVER:

A West Australian *Isopogon*, known popularly as 'Drumsticks.' The genus reaches its greatest development in Western Australia, although a few species are found in eastern Australia and extend as far as southern Queensland

Photograph—Kingsley Watson

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The Wildlife Preservation Society of Queensland is a non-profitmaking scientific and educational organisation centred in Brisbane. Through its official quarterly publication, WILDLIFE IN AUSTRALIA, it seeks to increase and disseminate knowledge of Australia's natural history, and in this way foster greater understanding of the urgent problems of conservation.

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The Editors of WILDLIFE are constantly looking for articles and photographs on all aspects of nature and conservation in Australia.

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AUSTRALIA'S RESPONSIBILITY

Our natural resources are on trust to every Australian. They must be used responsibly and guarded jealously. Conservation of these resources is not the responsibility only of the government. Too often we hear that some mysterious 'they' or 'the authorities' ought to do something about some aspect of conservation. While governments can do much they are not a national conscience. Each individual must play some part in forming social attitudes towards conservation.

At the same time, while we complain that the individual frequently shelves his responsibility we must also take issue with those who are over zealous in their protectiveness. There is a kind of protectiveness that distorts and brings into disrepute the whole concept of conserving the natural Australia. This is also a shelving of responsibility. We must have a balanced view and recognise the needs of settlement and increased agricultural expansion on the one hand, but, on the other, strongly oppose the attitude that our native plants and animals can be ignored and arrogantly dismissed as useless.

Take a look at how such a balanced view could be applied to three particular instances, examples of items constantly in the news and affecting all of us most closely—whether we like it or not.

There are places where the man on the land is plagued by kangaroos and wedge-tailed eagles. Judicious culling, though unpleasant, is none-the-less necessary. But it is irresponsible to advocate the complete extermination of these animals or to use them as scapegoats for mismanagement. Secondly, land developers often perform valuable services in opening up land needed for settlement. But to bulldoze every last vestige of vegetation as well as topsoil when preparing suburban land for sale infringes on the rights of the people who eventually buy this land. Thirdly, to impose a second-rate imitation of a foreign environment on our unique landscape is an act against the Australian character. It is also a falsehood to the people who travel long distances to see the real Australia. Local people have a responsibility to show and foster appreciation of their country as it really is, not as they think people will pay to see it. You will be astounded how much more interesting the real Australia is once you penetrate the smoke screen of tourist propaganda.

There is room for much improvement in current attitudes to these three and countless other cases. It is up to every individual to see that this is achieved. If we act irresponsibly towards wildlife, in the end we only act irresponsibly towards ourselves.

Many seemingly criminal acts against Australian wildlife are not perpetrated deliberately. They are the result of ignorance—conservation's greatest single enemy. Here WILDLIFE IN AUSTRALIA assumes its responsibility. It will inform and present a balanced, attractive view of Australian natural history. It will demonstrate the worth of what we have in trust and the best ways to preserve this heritage.

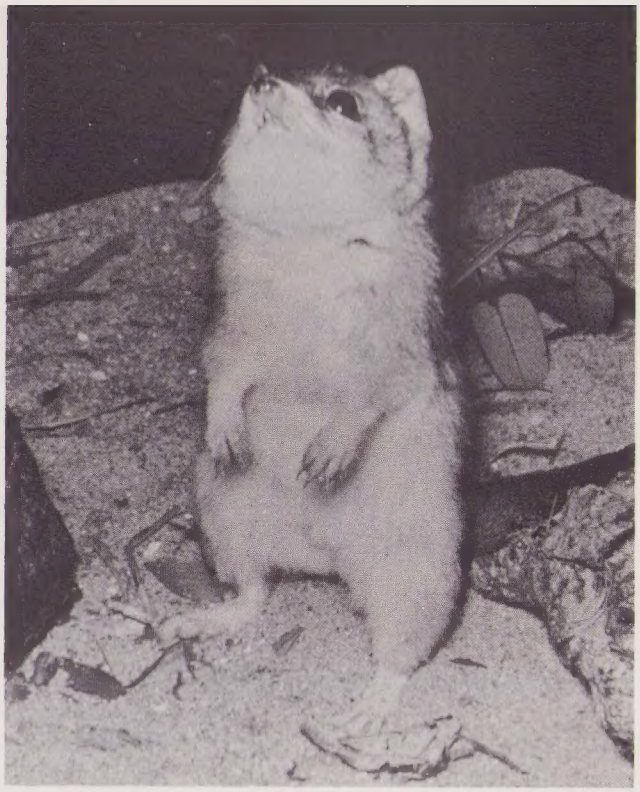
Stanley Breeden

Dead wedge-tailed eagles strung out along a fence in New South Wales. They are intended, no doubt, as a warning to other wedgies—but warnings could equally be extended to those who thoughtlessly destroy Australia's natural heritage

BURNETT CARLISLE

BREEDING THE MULGARA

by David Fleay



STANLEY BREEDEN

During the years 1954-55 the then Dr. Peter Morrison, now Professor of Zoology in the University of Wisconsin, was a Fulbright Scholar working on the metabolism of marsupials at the Physiology School, University of Queensland. One of his studies in this mammalian order was temperature regulation in relation to environment, and our Fauna Reserve co-operated to the extent of loaning Professor Morrison various living specimens that could be handled without complications to either researcher or researchees.

Before his return to America early in 1955 Professor Morrison left with me two of his special rarities originally dug from a sand ridge at Haasts Bluff, Central Australia in mid-December 1954.

They were the remarkable crest-tailed marsupial 'mice' (*Dasycercus cristicauda*) which by great good fortune happened to be male and female.

It was an exciting moment to meet for the first time in the flesh none other than this fabulous and very beautiful desert burrower recorded by Wood Jones as possessing the Aboriginal alias of mulgara.

The mulgaras intrigued us immediately with their lively activity by day, their extreme 'nosiness' for anything unusual and their incurable, lizard-like fondness, shared by the numbat, of basking flat-out for long periods in the sun. In fact, so largely diurnal were these fawn-coloured animals from the inhospitable centre, that their study and display proved one of the most charming and entertaining tasks I have ever undertaken. It left me without a doubt that the prize for general intelligence and bright personality among small pouched animals should go to this robust and lively burrower of the arid regions.

Truth to tell the term marsupial mouse for mulgara is quite a misnomer for this chunkily built desert dweller is not only one of the most efficient marsupial carnivores but at the same time male specimens may be half the size of the black rat (*Rattus rattus*), in fact the species might be described from its build as the wombat among so-called marsupial mice. Mulgara is a native name of long standing, and, being quite euphonious, should take its rightful place among such vernaculars as wombat, kangaroo, numbat, potoroo, and quoll.

LARGE AND GENTLE

The Haasts Bluff specimens were typical in that the male (and later progeny of this sex) recorded individual weights averaging 4½ ounces (127.8 grams) while Finlayson found an adult male from Cooncheri, lower Diamantina, South Australia, to weigh 6.1 ounces (175 grams). Now if we compare these figures with the less than ½ ounce body total of an average adult male of the fat-tailed marsupial mouse (*Sminthopsis crassicaudata*, heavier than the common mouse) then it can be understood that the mulgara is 'big game' indeed.

At the same time it is certainly true that female mulgaras are merely three quarters the size of male specimens and total weight of the Haasts Bluff female was 3¼ ounces (92.3 grams).

Once having regained normality thanks to the provision of plentiful insect food, mice, egg custard, etc., the two mulgaras proved quite gentle when handled—not biting so readily as members of the genus *Antechinus* and uttering the merest of heavy breathing or shushing sounds in the way of mild protest for they are typically 'soft spoken'. However on provocation they could bite—and severely—too!

Their coats of a brownish-fawn were thickly furred in sleek soft hair, the basal portion of the thickened carrot tails being clothed in bright rufous fur while the terminal halves exhibited the curious arrow-shaft arrangement of a comparatively large dorsal and smaller ventral crest of shining black erectile hairs. Possibly

The Simpson desert. It was a similar desert region that provided my mulgaras with their natural home

STANLEY BREEDEN

by means of this tail structure in a sandy environment leaps upon prospective victims are rendered more accurate and efficient.

Though comparatively well mannered towards one another the mulgaras when hungry proved tireless and deadly hunters of insects, lizards and the common mouse. Once a mouse was scented it was tracked down until finally spotted. Immediately the mulgara would point rigidly, 'frozen' in its tracks—its tail quivering lizard-fashion. Then in a flash it would leap upon the victim. It was a matter of brief moments for all to be over. Strangely enough although mulgaras may kill mice, lizards or small birds in a lightning rush these two and their descendants exercised rather comical and characteristic caution in dealing with grubs, beetles and spiders. They repeatedly shy off such items and commonly use their 'hands' in repeated scrabbling actions to confuse and weaken the victim before it is picked up and noisily crunched with bright-eyed enjoyment. The caution may be related to the pugnacity and ready retaliation offered by desert spiders and scorpions.

Naturally all efforts in housing and maintaining Professor Morrison's mulgaras were directed towards a record of family life, hitherto unrecorded, and when the animals paired determinedly on 1 July 1955 the male was very soon removed—for sad to say all members of his sex in the family *Dasyuridae* are irresponsible—never to be trusted anywhere in the vicinity of tender, new-born young.

So the temporary banishment of the male mulgara from the earth-floored sun flat, was not quite the injustice it may appear to be. Disappointingly, despite all the precautions not a single joey appeared. Possibly the failure was due to the fact that rehabilitation was still incomplete, or again anticipatory handling to inspect the 'pouch' area may have upset chances of success.

Whatever the reason I persisted in careful, balanced feeding and oestrus in the female (as in so many members of the *Dasyuridae*) occurred again almost exactly a year later.

Pairing for 1956 took place initially on 23 June and persisted (as in the case of the tiger cat, *Dasyurops maculatus*) for as long as twenty four hours. Because under these captive conditions there was no means of escape for the now torpid and frayed looking female the male animal was removed towards evening on 24 June.

THE PINK CLUSTER

Wasting no time in vain regrets and obviously following out her instincts the mother built herself a large and comfortable nest consisting of leaves and bark which she collected in her mouth from all over the cage. It was noticed that the 'pouch' as such did not exist, but its location normally almost indistinguishable from the abdominal fur, had now become differentiated as in *Dasyurus quoll* by the outward growth of long tufted white hairs marking a shallow ridge on each side of the mammary area. From the mother's activities, or more correctly lack of them, when she became somewhat of a recluse in her nest, it seems fairly certain that the joeys crawled to the teats on or about 21 July following a gestation period of some 30 days.

In view of prior rather unfortunate experiences with small marsupials I dared not handle the reluctant mulgara to make absolutely sure. However confirmation was absolutely certain at the age of 14 days when the mother ran up the netting front of her cage to seize a grasshopper. Tiny, very pink blobs, almost hidden in the protective depths of the specially developed white hairs, furnished conclusive evidence that the exciting event was true indeed.

DAVID FLEAY

The burdened mother arches her back to keep her nine-week-old 'pink cluster' clear of the ground

Week by week the pink cluster in the open mobile nursery became more pronounced and better observed, particularly when mother ran up the netting to seize offerings of insect food. At the age of five or six weeks, with individual lengths in the curled posture measuring $\frac{3}{8}$ of an inch, it was finally ascertained that there were six babies in the 'clutch'. Up until that time mother had never stayed motionless for sufficient time for any observer to be sure of his count —and they did resemble a jumbled mass of cocktail sausages!

It is worthy of note that Wood Jones records a maximum of seven in pounch areas of wild-caught mother mulgaras. The number of teats in the species varies between six and eight. Quite bulky by now, the babies had become tightly packed and each remained motionless as the sphinx during the journeys of the severely handicapped mother. Throughout this period of 'permanent' attachment the mother stepped high (see photograph) with arched back and raised tail to avoid dragging the babies more than could be helped over the various obstacles in her path. It was the familiar old story common to so many *Dasyurid* mothers at a corresponding stage when the hampered hungry mother and the babies themselves are at the most vulnerable stage. At this time in particular mother mulgara was observed to indulge in the habit of regurgitating food into her mouth and reswallowing as in the incipient 'cud chewing' of kangaroos.

A DEVOTED MOTHER

The morning of what was approximately the 58th day (16 September) saw the black-nosed mother frisking through the sunlight, sparkling-eyed, care-free and full of joy. Little wonder for when she sat on a log to go through a methodical toilet of licking and cleaning we saw that her 'pouch' was so empty it was distinguishable only as a pinkish patch among the side growths of longer paler hair. All babies were missing! No longer did she have to wear that tiresome family as she had done without a moment's respite for over eight weeks, and at the moment its entire personnel was safely tucked away inside the nest.

The mother seized upon this wonderful opportunity to carry mouthfuls of fresh dry grass to the nest and there arrange it for additional comfort and warmth. However the fact that the clutch of youngsters (four males and two females) was no longer carried (or should I saw dragged!) around in an undetachable state did not mean that they stayed put indefinitely. As often as not the mother sallied forth for a period of weeks in advance of this date *with* the babies. Now faintly covered in light grey coats they hung grimly to her elastic but sorely tried teats.

Carefree moments, with the babies at home uttering sibilant cries of 'cha-cha', often found the mother bolstering up the hidden nest with extra material or sitting up to wash her pouch, face and flanks. Such activities were interspersed with a completely spread-eagled shut-eyed stance in uninterrupted hot sunlight when she appeared to delight in an astonishing intensity of heat. At the other extreme it is as well to note that when the sands of the desert grow cold the vitality of mulgaras may drop to a very low ebb. Obviously body temperature falls to a considerable extent and on frosty mornings mulgaras are often torpid.

The babies' eyes opened at the age of $10\frac{1}{2}$ weeks. They were 'bull headed', furred in yellowish brown as far as mid back but further down thinly haired with their typical fat tails black tinted terminally. In fact there was little to distinguish them from baby tuans (*Phascogale tapoatafa*) of similar age. They had become fairly active, and if disengaged from mother for the merest fraction of time called 'chup-chup' in frantic anxiety until able to hook on to her comforting warmth once more. Naturally with six babies each measuring some $3\frac{3}{4}$ inches in length the mother was now severely hampered and moved most awkwardly under the load.

So important had it become for the lone parent to hunt *without* such a killing handicap that now and earlier it was highly diverting to observe her method of shedding the clinging brood from its 'death grip' on her teats. Before a shopping expedition mother suddenly treated all her six offspring to a rapid shaking or vibration of the abdominal area so that one by one each unfastened its anchorage and bunched up with brothers and sisters in the nest. Mother then left them safe, sound and hidden while she scampered off—first of all going through a thorough toilet performance before seeking food and relaxing for that heavenly session in the sun.

By late October at the age of $12\frac{1}{2}$ weeks, or nearly three months, the six black-tailed offspring began to undertake short and very furtive excursions of their own—but meetings with beetles and grubs gave them cause for alarm and usually ended in frantic sprints for home and mother. She, poor soul, up until this stage of initiative by the babies could at times only trundle with the utmost difficulty should they happen to hop aboard. In fact she was almost obliterated under the massed bodies of the clinging joeys.

Like baby quolls (*Dasyurus quoll*) there is a definite play age in mulgaras with highly entertaining 'stalkings' of one another and simulated 'ferocious attack'. Like their parents however, they were not particularly 'talkative' and having, since this family event, observed and bred the tiny planigales (*P. ingrami*) I am satisfied that their midget cousins are far more vocal while, of course, there is nothing in either to compare with the loud sibilant hisses of *Sminthopsis murina*.

DAVID FLEAY

Four tireless and tiresome 'babies' at 12 weeks old make their mother's lot a far from happy one

FURTHER PROGRESS

With the coming of November the babies attained the age of three-and-a-half months. To all intents and purposes they were sub-adults, three-quarters grown and independent. Moving most actively in the early morning sunlight, they were on the prowl also in late afternoon and at night. Established in a large concrete floored run with special hollow logs, grass tussocks and burrowing space they did very well indeed and proved fascinating 'man in the street' exhibits because of their good looks and fearlessness combined with the unusual habit (for a marsupial) of skipping about by day. Imagine their brash outlook in smelling noses through the wire with visiting dogs! Though not good climbers they never-the-less ran skilfully up logs or wire netting, particularly when their keen sense of smell took them in pursuit of grasshoppers. Unfortunately small skinks were in the habit of entering their quarters with the inevitable result that the mulgaras caught many and devoured them. Infested with nematode worms these lizards evidently did not agree with the *Dasycercus* family for over ensuing years several of its members died in extremely poor condition.

However there was a further breeding event in which four joeys attained adult status in 1958 and the family was still represented as late as 1962.

It must be admitted that, allowing for the usual placidity of mulgaras among one another, disagreements do occur and, as in bandicoots, tails are sometimes badly chewed or even bitten off altogether.

It is also interesting to bear in mind that this most entertaining and quite delightful desert marsupial is the one reported by Wood Jones (*Mammals of South Australia Part 1*) to multiply in an astonishing manner during the passage of mouse plagues across central Australia. He wrote that its services are of the greatest value. In view of the fact that 'pouch' development and associated pairing in our animals over 1955, 1956, 1957 and 1958 occurred only once in the twelve months —as in so many *Dasyurids*—falling each of those years within the limits of a five week period beginning in the last week of June I have wondered whether the multiplication during mouse plagues (which guarantees plentiful food for their predators) was not due to successful development of full pouch loads in the winter seasons rather than an acceleration of the breeding cycle. In very hard times it is doubtful whether mother mulgaras would breed at all, and in any case scarcity of food would automatically cut back chances of the successful survival of all the offspring originally appearing in the pouch, just as easy food would tend to guarantee 100% success.

SCIENCE AND WILDLIFE No. 1

POPULATION CONTROL IN ANIMALS

At all levels the techniques and methods of modern science are transforming our knowledge and attitudes. To natural history as such — to botany, zoology and ecology — this scientific revolution has brought new horizons. WILDLIFE IN AUSTRALIA, therefore, feels it high time to publicise some of the more recent developments. Our new series begins with an article on Population Control in Animals, which has, of course, a wide relevance to the modern world. Mr. David Corke, a well-known naturalist-photographer from Melbourne, will write this column regularly for WILDLIFE IN AUSTRALIA.

Unlike man, most animal populations seem to be regulated to fairly constant population levels. What sort of mechanism is responsible for such strict control of the size of population?

In an article by Professor Wynne-Edwards, published in the *Scientific American*, August 1964, a new hypothesis is set out. This suggests that constant population levels are achieved by forms of social behaviour that limit reproduction and so avoid over-exploitation of food resources.

Up to date the prevailing idea has been that populations are regulated by negative natural controls—such as predators, starvation, accidents or disease. While this assumption seems fairly reasonable, the idea does not stand up to closer examination. Many animals, such as lions, eagles and skuas have no predators and are not readily subject to disease, yet they maintain stable levels of population. Disease does not act on a large scale to control animal populations. Then there is the question of starvation. Except for unusually dry or cold conditions all individual animals in a habitat get enough food to survive—the unusual climatic conditions are accidents of weather and do not arise from the density of the population. However, the density of a population in a habitat does depend directly on the size of the food supply. So we have a situation in which no individual starves, but the population does not outgrow the food supply. For many animals, then, neither predators, disease nor starvation can account for the regulation of numbers. Accidental mortality can be ruled out because it is so unpredictable and haphazard.

All these considerations point to the possibility that the animals themselves provide the necessary control!

Birds that feed on seeds or berries during the autumn find themselves in a situation where, to begin with, the stock of food is so abundant that it could feed an enormous population. As the birds must depend on this food supply for weeks or months they must somehow restrict the size of their population in advance. Thus the threat of starvation tomorrow, not hunger itself today, seems to be the factor that decides the density of the population.

What are needed are some restrictive social mechanisms or conventions that tend to limit population density. The author points out that we need not look far to realise that animals do indeed possess conventions of this kind—one of the best known being the territorial system of birds. The practice of staking out a territory for nesting is common among many species of birds and this puts a limit on crowding. Instead of competing directly for the food itself, members compete furiously for pieces of ground.

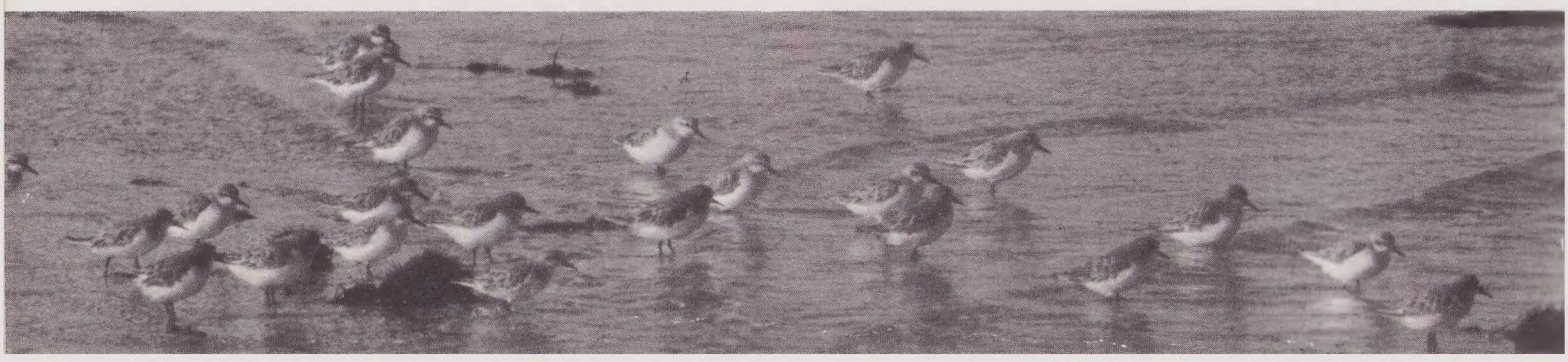
This territorial convention is just one example that takes on many forms—some much more sophisticated. These include the competition among sea-birds for a place in the rookery; the competition at dawn and dusk among songbirds, cicadas, bats and frogs. This daily community display puts a changing pressure on the members taking part. If the stress is great enough a reduction in the population can be triggered off.

This new hypothesis, that animal populations limit their numbers by social conventions, seems to answer several of the major questions that have concerned biologists, such as the origin of social behaviour; the function of the 'peck-order' system among birds and the chorus of birds at dawn and dusk.

The author also points out that the new hypothesis has many interesting ramifications—especially those concerned with human population control and the origins of man's social conventions. Primitive man, limited to the food he could get by hunting, evolved a system for restricting his numbers by tribal traditions and taboos, such as offering human sacrifices and conducting head-hunting expeditions against rival tribes. Consciously or not, these customs kept the population nicely balanced against the food supply. When the agricultural revolution removed this limitation there was no longer any need to limit the size of the tribe. Indeed power and wealth came to those tribes with large populations. As the old checks on population growth were discarded, the rate of reproduction became a matter of individual choice rather than tribal or community control. It has remained so ever since.

DAVID CORKE

What factors ensure that the population of these stints does not outstrip food supplies? A recent suggestion is that the regulating mechanism is provided by the birds' social behaviour



PRESERVATION IN 'PERTH PARK'

Statue of Lord Forrest

by J. S. BEARD

King's Park, Perth, has long brought natural beauty to the heart of Western Australia's capital. Now it takes on new importance as the scene of Australia's first official and systematic attempt to preserve its native flora.

On Monday, 4 October, 1965, the Premier of Western Australia, Hon. David Brand, M.L.A., will officially open the new native plant Botanic Garden in King's Park which has been in preparation since 1962. This opens a new and exciting chapter in the long history of King's Park, and brings it to the forefront of the conservation field. The Park itself is a tract of almost 1,000 acres of state land in the heart of the metropolitan area of Perth, bounded on two sides by the Swan River. Reserved first for park purposes in 1872, enlarged in 1890, beautified from 1895 onwards, King's Park has come to fulfil three main functions: as a park it preserves the scenic heights along the Swan River and holds the key to the beauty of the city; as a National Shrine it preserves the State War Memorial, the Honour Avenues and many other memorials of military and historical significance; as a botanical reserve it preserves in a wild state the original native flora of the Perth area, and now in addition a great cultivated collection of native plants of the whole state.

One of the many attractive paths which pass through natural bushland enriched by additions from the nursery

J. S. BEARD

THE PARK'S PROGRESS

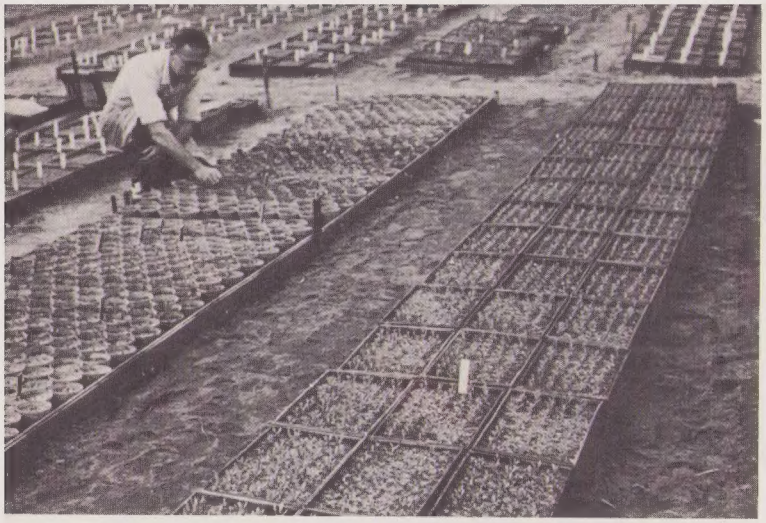
John Septimus Roe, Surveyor-General 1829-1870, to whom there is a memorial in the Park, may first have conceived of a reserve on Mount Eliza but of this we have no certain knowledge. Malcolm Fraser, his successor, put up, on 12th July 1871, a plan for gazetting 432 acres of land proposed on the suggestion of the Governor Sir Frederick Weld, for the purpose of a park and recreation ground. Sir Frederick approved this and it was gazetted in 1872. John Forrest, when Surveyor-General, secured in 1890, the extension of the park to 980 acres on more or less its present boundaries.

Later in 1890 Forrest became the first Premier of Western Australia and personally took the lead in the improvement of the Park which he had extended. By 1895 funds were available for landscaping and in 1896 a Board was appointed under Forrest's presidency to administer 'Perth Park'. This system still continues. In Forrest's lifetime the Board laid out two carriage drives through the Park and established gardens on about 50 acres after clearing the original bush. The name was changed to 'The King's Park' in 1901 in honour of the accession of King Edward VII.

Mr. A. Lovekin succeeded to the Presidency of the Board in 1918 and in his time the Honour Avenues (in which individual trees are dedicated to fallen servicemen) and the Centenary Avenue of 1929 were planted. In addition the State War Memorial was built, but financial difficulties prevented more horticultural development. In fact, during the economic depression funds were so short that Mr. Lovekin, who was a wealthy newspaper proprietor, was paying out of his own pocket to maintain a minimum level of maintenance in the Park. This difficult situation continued until after the Second World War, when a new period of development began, centred on the Botantic Garden project.

A NEW PROJECT FOR AUSTRALIA

In the world at large, botanical gardens dedicated to the cultivation of their country's native flora as a means to its preservation are no very new thing, although in the history of botanical gardening they do represent a relatively recent twentieth century development. South Africa's National Botanic Garden at the Cape was established in 1920, and there are several such institutions in California, in the Alps, and elsewhere where the flora is of a particularly interesting character. The movement has been slow to come to



The all - important nursery which raises nearly 100,000 plants every year for Park and Botanic Garden J. S. BEARD

A sweeping view over the bay from Mt. Eliza J. S. BEARD

Australia, but the West, fittingly for the Wildflower State, has now taken the lead and the King's Park Botanic Garden is the first official project of this kind in Australia to be opened.

In the nineteenth century botanic gardens were essentially what are called 'gardens of acclimatisation', devoted to experiments in the introduction and establishment of all kinds of exotic plants, both ornamental and economic. We can readily understand the need for this in the Australia of pioneer days when the settler had to import all the plants and animals he needed to help him make a living. H. W. Caulfield, Curator of the Brisbane Botanic Gardens, has given an account of the early work of that garden in a recent issue of the journal 'Australian Parks.' We read that 'Walter Hill was a most enthusiastic Director, and, apart from building up a garden for the citizens of Brisbane, he directed his efforts to the field of plant introduction, particularly in relation to the field of economic crops. . . . Hill . . . played a big part in the establishment of the commercial sugar industry. In 1872 . . . Hill . . . distributed 50,200 cuttings of sugar cane . . . Hill applied himself also to the introduction of grapes, mulberries, coffee, tea, ginger and tobacco.'

The botanic gardens in the state capitals of eastern Australia therefore, being nineteenth century foundations, contained magnificent collections of plants from all over the world but hardly any Australian natives. Today the phase of introduction and acclimatisation is largely over or is carried out by other means, and we are much more interested in the saving of native flora threatened by increasing human population and extending land use. This may be approached in two ways: **conservation,** which affords continuity of a species by natural means, setting aside large reserves where it may continue to flourish, and **preservation,** the ensuring of continuity by artificial means, chiefly by its introduction into cultivation.

Conservation alone is not enough. Reserves cannot be created to include the habitats of every single species, and even those species they do include cannot be guaranteed survival if vegetation management is not fully understood. Preservation is the indispensable second line of defence. It is not new. *Ginko biloba,* the maidenhair tree, has been extinct in the wild and kept alive in cultivation in China for over 3000 years.

WORK BEGINS

Following moves by the Royal Society of Western Australia in 1956, the government appointed a committee in 1957 which examined many possible sites all over the metropolitan area and recommended King's Park as the most suitable site for the garden. In 1958 Dr. W. S. Stewart, Director of the Los Angeles State and Country Arboretum, California, visited Perth and was asked by the government for a detailed report and recommendations, which he based upon the site in King's Park. His report was adopted in 1959 and the King's Park Board was entrusted with the task of bringing the Botanic Garden into being. The present writer was recruited as Director and arrived in September 1961. A detailed 5-year plan was drawn up and submitted to the government at the beginning of 1962, which was adopted and implemented. A seed-collecting organisation was set up at once, and a nursery opened in April 1962. A first crop of 14,000 native plants, embracing some 759 species, was grown in the first season and was available for planting in the winter of 1963. In the interim the Botanic Garden site of 25 acres was chosen, surveyed and planned. Unwanted bush, trees and shrubs were removed, the network of main grass paths was designed, cleared and graded. A water supply was obtained and reticulated throughout. Soil was prepared for planting. Each winter further planting has been done and the Botanic Garden now contains about 1,000 different species; yet Western Australia is thought to contain 4,000 species of horticultural value, so that we have still far to go, and the work of collection will take many years.

Most of the plants have grown readily and well, once propagated. Difficulties lie more in obtaining germination from seed, or in obtaining seed at all in certain families, rather than growing in the Garden. While of course the Garden is not without its problems nearly all the plants that have left the nursery have, with certain exceptions, proved quite amenable to cultivation and have progressed steadily to flowering stage. Some flowered in one year or two, others are taking longer. The most spectacular successes, probably, have been *Grevillea leucopteris* of which plants reached seven feet high and flowered in two years from seed, and *Kennedya nigricans* which climbed 10 feet up sheoak trees and flowered in one year.

The planning and arrangement of the garden has been based on an ecological pattern. A certain number of broad habitat groups were decided upon, such as the jarrah forest, the karri forest, sand heaths and so on. These groups were then allotted to distinct sections of the garden, and when planting is done all material goes into its appropriate group. In this way plants which normally associate in nature are planted together and can be given common treatment as regards shade, watering and soil preparation. Thus the jarrah forest section is one with an existing good stand of trees. Ironstone gravel and loam were added to the soil, and shrubs planted are those typical of the Darling Range such as *Leschenaultia biloba.* On the other hand the sandheath section was almost entirely cleared of existing growth to provide full light, the soil required no additives other than compost, and the collection consists of the great wealth of sandheath shrubs. In addition to this treatment there are special display collections of kangaroo paws, wattles and feather flowers (*Verticordias*). The garden begins to emerge from the bush as the planted items start to flower and as the walks and paths take shape with the provision of stone edgings and the growth of grass.

The bush on the site, which consisted mainly of banksias and casuarinas with occasional eucalypts, was heavily thinned. No complete clearing was done except in a central area planned as a water garden, as it was intended to develop a natural-seeming wild garden by gradual conversion from existing bush. Finally water was laid on from shallow spears at the foot of Mount Eliza, pumped to the top of the mount, and reticulated through a ring main of 4-inch cement pipe encircling the garden and over a mile in length. Minor reticulation was by 1½-inch polythene pipe to field points for quick-coupling sprinklers at 40-foot centres. The grass walks have their own fixed sprinkler system installed at ground level. All watering therefore is done from labour-saving sprinklers, avoiding the use of hoses or portable irrigation piping.

A small valley in the garden is being used to provide a central picnic lawn with an ornamental water garden. A winding watercourse 600 feet long and constructed like a mountain stream runs down the centre connecting a string of pools, the water being returned from the bottom pool to the top by pumping. The top pool has been designed to accommodate in due course a memorial fountain to the pioneer women of Western Australia. In the lower pools there is provision for growing bog plants and riparian species.

SCIENTIFIC ACTIVITIES

The Botanic Garden project is scheduled to cost £165,000 over the first five years, in addition to the regular budget for park maintenance. All finance comes from the Western Australian State Government.

The work of the botanic garden does not begin and end with the formation of a garden-full of plants. A botanic garden worthy of the name is a scientific institution which contributes to research and education.

PETER SLATER

Elythranthera emarginata, *the largest of the enamel orchids, is found in sandy soil in the woodlands of the south west*

Eucalyptus caesia, *a widely distributed mallee with ornamental foliage and buds*

STANLEY BREEDEN

Banksia coccinea, *known as the scarlet banksia, this beautiful plant flowers in the springtime in the south-west of the 'wildflower state'* J. S. BEARD

Just as a museum has a collection of preserved specimens on view to the public but also a qualified staff who study, maintain and add to these collections, a botanic garden maintains a living collection of plants on display but uses them for biological study and demonstration. The most important scientific activities of the King's Park Botanic Garden at the present time are:

Preservation—in general, discovering **where** our plants grow, in particular locating of rare or local species which are threatened by land development, and establishing them in the garden. In view of the very rapid pace of land development in Western Australia (1,000,000 new acres ploughed under each year) this work is urgent and needs to be further expanded.

Ecology—discovering **how** our plants grow, i.e. study of the soil and climatic conditions under which native species occur in the wild. This information may be vital to their establishment in cultivation.

Horticulture—discovering how to grow our plants. At the outset, only a relatively small number of West Australian natives had been grown by enthusiastic amateurs. In dealing with literally hundreds of others we had everything to learn. Comparative experiments are conducted on propagation from seed and cuttings. Research is being done on the longevity and storage of seeds, and on dormancy problems. Specialised research is in progress on species of particular interest and difficulty such as the West Australian Christmas Tree, *Nuytsia floribunda.* One of the finest flowering trees in the world, Nuytsia belongs to the mistletoe family and is a root parasite, and unfortunately it is generally reputed to be impossible to cultivate. However it is being found that if seedlings are given a host plant such as couch grass to attach their roots to, they can be induced to survive and make growth, and there is every hope of success with this plant at present. In the garden generally there is constant experiment with soil preparation and with the watering, mulching, pruning and other requirements of native plants in carrying them forward to the flowering stage.

Nuytsia floribunda, *the West Australian christmas tree, is one of the world's finest flowering trees. Special problems in its cultivation are being studied in King's Park*

KINGSLEY WATSON

KINGSLEY WATSON

Wattle and kangaroo paws growing in sandy wildflower country in the south-western part of Western Australia

General Biology—discovering the life histories of our plants. Many plants have entirely different leaves and growth forms in the seedling stage and this has been very little studied in the case of Australian plants. We need to know also how flowers are pollinated, how long the seed takes to mature, what the fertility rate is and so on.

Extension Work—it is expected that the success of the garden will serve to popularise the growing of native plants by the public. Seeing a striking native species in flower in cultivation is likely to awaken a desire to grow it at home, and seed is made available to the public by the Park, as well as to other botanical institutions.

The magnitude of this service needs to be stressed. In 1964 the Park published a seed list offering 950 species, and 3393 seed packets were despatched to 35 different botanical institutions in 18 different countries, while 7709 packets were sold to growers in Australia. In handling this volume we are materially assisted by the W.A. Wildflower Society.

Information acquired on cultivation is passed on to growers through the Society and other State branches of the Society for Growing Australian Plants, using the medium of the Society's journal. Within Western Australia, members of the staff constantly lecture and demonstrate, and the nursery is opened to conducted parties at regular intervals. There is a nature trail for children in the Park bushland used regularly by the Gould League, and as the Botanic Garden develops it is expected to become of value for nature study groups. A three-year course for students in horticulture and park administration was begun in 1965 under the auspices of the Education Department.

Banksia prostrata. *This species, which occurs in the open sandplains of the south coast area of Western Australia has a pinkish-brown flower*

STANLEY BREEDEN →

SEED COLLECTING

By F. LULLFITZ

photographs by BURNETT CARLISLE

The seed collector's work is of vital importance to the botanical garden. But seed collecting is also a fascinating and rewarding hobby for the home gardener, which directly assists the work of preserving native flora. Here F. Lullfitz, seed collector for the new King's Park Botanical Garden, gives advice on collecting for the home garden.

Seed collecting, which is the first step towards cultivating Australian native plants in the home garden, can be an interesting and absorbing hobby. It involves far more than simply gathering seeds and planting them. Properly done it leads to a deeper understanding of plant biology, and adds a new dimension to your enjoyment of gardening.

First of all, it is better to study the seed as a stage in the plant's life cycle than as just the starting point of new growth. If possible watch the plant through bud and flowering stages to the setting and ripening of the seed, and note its dispersal mechanism—winged seed, edible seed? Some plants retain their seed for long periods, even years, after maturity *(Hakeas, Banksias, Eucalyptus)*; others ripen the fruit and discharge the seeds immediately they mature *(Acacia* and legumes such as *Hovea* and *Daviesia)*.

Collectors will find added interest in keeping a notebook in which all relevant information about their plant is entered. Give the plant an identity number (and label the plant itself with an aluminium tag bearing this number); leave a space for the common name and the botanical name, enter the month of flowering, colour of flower, habit of growth, type of soil, and associated plant communities. Take a specimen about 8 inches in length from the plant, with leaves and flowers and perhaps buds (particularly in the case of eucalypts) and press between sheets of newspaper for later identification by the Curator of the state Herbarium, when the correct name can be entered against the number in your notebook, and a label bearing both slipped into the container with the seeds.

Observation and inspection will soon help the collector to accurately determine when seed is immature or ripe.

The author surveys a typical Western Australian scnee. By collecting and germinating seeds from such regions a valuable record of native flora is built up, and a major contribution to plant presevation is made

J. S. BEARD

Where the seeds discharge from the end of the fruit an inspection of the valves or flaps which cover the end will indicate whether the seeds have discharged or remain within the fruit. Immature seeds can be crushed easily and are succulent and sappy. The mature seed will turn yellow to various shades of brown and become hard to very hard. In the case of plants which shed their seed as soon as it is ripe, collection can be assured by tying a paper bag or a silk stocking over the flower head when the embryo fruits begin to set. To guard against insect attack lightly dust the flower head with insecticidal powder. Seed taken direct from the plant is much to be preferred to picking it up from the ground. A great deal of damage, which is not always apparent, can be caused by birds and insects, particularly ants.

The seed vessels of plants which normally retain their seed for long periods sometimes require special measures to free the seed but usually a few days exposed to direct hot sun will cause fruits to open and shed the seed. Place the fruits collected in a paper or plastic bag and when the valves of the fruit open after exposure to the sun a vigorous shaking of the bag will help to expel the seed.

Some fruits contain, as well as seeds, a quantity of 'packing material'. This has no value and should be discarded before storing the seed in containers.

If difficulty is experienced in identifying seed from its 'packing' crush one or two of the different pieces of material. The 'packing material' is hard and woody. The seed has a white kernel and will leave a smear of moisture or oil on the crushing tool.

When the seeds have been separated from seedbearing material, store them in screw-topped jars, envelopes, tobacco tins or the like. Place a little insecticide powder with the seed when you pack it and label with the time of collection. The period of viability of seeds (that period in which a seed is capable of germinating) varies considerably with different species. In some it may be as short as six to twelve months, while some of the acacias have been known to germinate after fifty years. It might be expected that the fresher the seed the better the chances of germination, but this is not always so. Fresh seed of *Verticordia* and *Pileanthus* which germinated poorly have been left in the seed bed undisturbed for a further twelve months and then germinated far more freely. However, in most instances it is wise to use seed which has not been stored for too long.

Experiments seem to show that seed collected from plants which have been cultivated for several generations gives better germination results than seed from plants in their native state, so it would be advisable to procure, whenever possible, seed from garden-grown plants, particularly in the case of annuals such as everlastings and flannel flowers.

Example of notebook entry:

No. 27: *Eucalyptus erythrocorys* (Ilyarrie) coll. 7th Jan.; fl. Dec.-Jan.; fl. yellow, buds red-capped; small tree to 12', adaptable. King's Park.

1

2

3

SEEDS OF SOME AUSTRALIAN PLANTS

1 Grevillea banksi
2 Hakea gibbosa—*flowers and closed seed-pods*
3 Hakea gibbosa—*one seed-pod has opened, exposing the two winged seeds*
4 Callistemon rigidus
5 Leptospermum sp.—*the closed valves indicate that the seeds are still within the pod*
6 Eucalyptus sp.
7 Eucalyptus sp.—*all these seeds came out of the one 'gum-nut'*

6

4

5

7

LETTERS TO THE EDITOR

BIRDS OF PARADISE THREATENED?

It has come to my notice, through the press and other periodicals that an Ordinance is to be introduced in the New Guinea House of Assembly permitting an open season on all species of birds of paradise.

Such an astonishing and retrograde Bill will allow all and sundry to exploit, in the fullest possible way, these magnificent and unique birds to inevitable extinction.

Such a step can only produce destruction and decimation likened to that of the 'osprey' trade amongst egrets, which birds are only beginning to recover.

It is the duty of all interested, in this day of imperative conservation, to deplore this Bill and, through protest, to prevent its passage into the Territory's law.

Gordon Bennett, Ascot, Qld.

We are happy to report that the Bill has been defeated. WILDLIFE IN AUSTRALIA will give a full account of the plight of the birds of paradise in a coming issue.—Editor.

A bird of paradise—should these birds be shot?

DEREK S. DUPARCQ

PRAISE INDEED

I can't tell you how pleased I was when I saw your publication for the first time yesterday. As a teacher this is exactly what I need to foster my children's awareness—but I am disappointed to have missed previous issues. Do you have previous numbers that I can buy? I want to keep them in a folder to which the children can have access.

Apart from my responsibility as a teacher, I have a personal interest, and will welcome any news (in Wildlife or otherwise, about your projected Wildlife Preservation Society).

Having been born in Britain, your magazine provides a marvellous way for me to know more of Australia and its (often) unique flora and fauna.

Audrey Cummin, Frankston East, Vic.

Backnumbers are available from Box 2030 X. The Wildlife Preservation Society of Queensland has been established for three years, and all other States have similar organizations. We in Queensland are always anxious to find new members and supporters.—Editor.

SICK REPTILES

For the past couple of years I have been very interested in 'diseases' of reptiles, particularly those caused by various blood parasites. It is very difficult to obtain obviously 'sick' animals for study, and it would be greatly appreciated if you could assist me by publishing this letter in 'Wildlife'. Anyone wishing to contact me could do so at the Animal Research Institute, Yeerongpilly, Brisbane, Qld.

I feel that your magazine is filling a vital need in informing people of the necessity for the preservation of our natural flora and fauna. However, it would be pleasing to see more done to protect our native reptiles, which, in some areas, are being completely wiped out.

P. E. Green

UNDERPRICED

I was brought to notice your publication 'Wildlife in Australia' a few days ago. I believe it to be the only publication of its kind in this country.

Personally I think that contributions should not be so centred about Queensland because the journal would have more national interest, but most of all I would think that more colour pictures should be included.

The price for such a journal as this is ridiculously low—I think that 10/- per copy would not be too much for four copies a year.

I will support your journal by subscribing to it.

Finally, in a few months time I shall be choosing Christmas presents, and a subscription to this journal springs to my mind as a suitable gift for many of my friends overseas.

Alan E. Stearn, Ourimbah, N.S.W.

I am glad you enjoyed our last issue, and agree with you that we must be as national in our coverage as possible. With regard to colour photographs, I'm afraid the cost at present would be too high and to be competitive the price must remain 4/-.—Editor.

BLACK SWANS

Following on Mr. Lavery's article on the breeding colonies of black swans near Bowen, and his comments on the birds' distribution, I should like to put on record the fact that swans have bred at Mt. St. John, Townsville.

Mr. St. John Robinson, former owner of Mt. St. John, and founder of its private zoo and sanctuary, had constructed a dam to form an artificial lake larger and deeper than the natural lagoons on the property, and had planted it with suitable grasses. The dam was eventually destroyed by the local authorities because it was held responsible for the flooding of the near-by road after heavy rains, but while it lasted the lake was the nesting place of large flocks of pied geese and other wild fowl.

Before the lake existed I had never seen more than five or six swans together in the neighbourhood, and in June 1948, a number could be seen sitting on their nests. Though this was new to me, I did not realize that it was altogether unusual in North Queensland. My record of the nesting mentioned no numbers, probably because I did not have time to make a reliable survey, and failed to make a follow up visit. My hazy recollection is that I saw twenty or more nests, and that Mr. Robinson afterwards mentioned a much higher figure.

Nancy Hopkins, Wavell Heights, Qld.

LANDFORMS AND HABITAT

By J. N. JENNINGS

Photographs by the author

Many factors help to shape the natural vegetation and animal populations of individual regions. Among the most basic and important is the very structure of the land. This study of landforms and the associated habitat has much to teach the student of natural history.

Take the new road from Buchan in Gippsland through Sugganbuggan to the Monaro and, if it is your first trip, you will be thrilled near Black Mountain by a sudden and tremendous view over the broad, deep valley of the Snowy River. Successive earth movements through the long span of the Tertiary period, perhaps dragging on into the last million years or so of geological time which we call the Quaternary, have raised this south eastern corner to the highest levels found in Australia. The high plateaux here receive ample supplies of rain and snow and their configuration is such that much of the resulting run-offs is gathered into the Snowy River. Thus has this river acquired both the power and the opportunity to carve a mighty trench reaching far back into this corner of the continent.

Even from the plateau edge, if you look carefully down to the Snowy and its tributaries, you will see that the vegetation below is distinctive in colours and shapes. When you have wound your way down to the bottom, you will realise immediately that you are in a habitat strange for the south east. The more open spacing of the trees and the sparsity of ground vegetation will tell of dryness and, if you recognise them, the dominance of white box and Murray pines will reveal the surprising fact that as far as vegetation is concerned you might be out in the western plains. Why is it that this dry country vegetation has penetrated into this generally wet corner of the continent?

The answer lies in the landforms. The Alps to the west and the coastal ranges rimming the southern tablelands to the east rob much of the moisture from air masses, which might otherwise bring rain from the southern ocean or the Tasman to the Snowy valley, and air descending into the latter is warmed and dried by descent, reducing further the chances of rain there. It illustrates very well the 'rain shadow' effect of relief.

This example of the Snowy valley embodies the main point of this article. In earlier issues of this journal it has been maintained that it is essential to study the action and reaction on one another of plants, animals and environments if we are to preserve the national heritage of wildlife (or at least some part of it) and if we are to conserve the country's national resources.

Breaking the monotony of the Nullabor Plain are occasional steep-sided holes due to the collapse of cave roofs. These are important nesting sites for birds in this treeless country

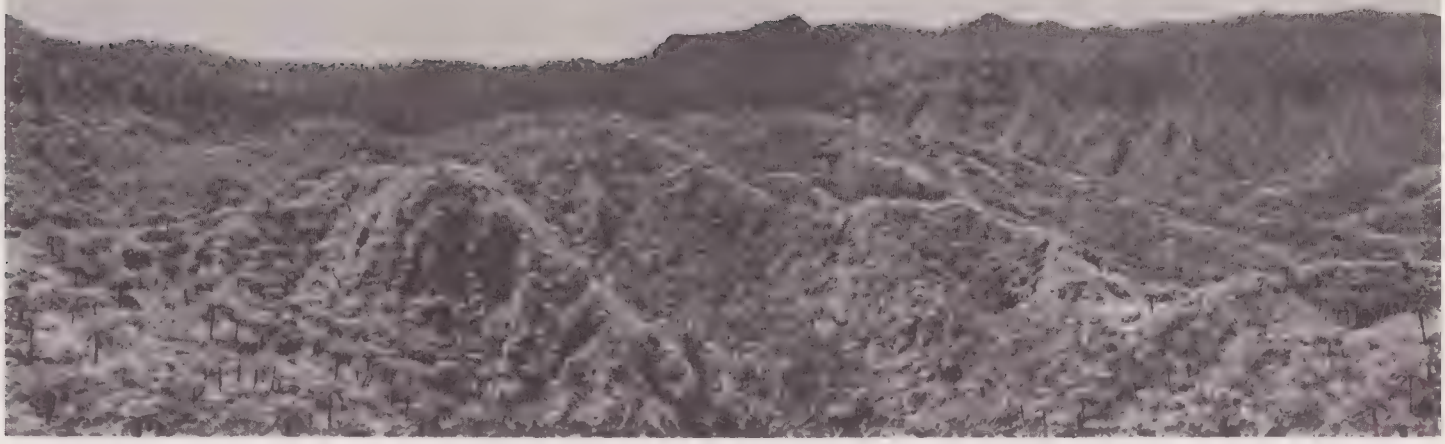
Whether this study centres on individual biological species or on interdependent communities of plants and animals, understanding of their habitats is a vital part of the task. These habitats are compounded of many things but amongst the basic ones are landforms and the processes which fashion them. The characteristics of the earth's solid crust form, as it were, the framework of habitat, strongly influencing other environmental attributes and often defining the units in terms of which habitat is best studied. Thus the units, the 'land systems', by which the Land Research and Regional Survey Division of CSIRO makes its reconnaissance surveys of the natural resources of Australia and New Guinea, are mainly defined in terms of landforms. So ecologists and conservationists need to concern themselves with the findings of geomorphology, which investigates the origin and evolutions of landforms, together with the rates and mechanisms of the processes modelling them.

DIFFERENT CLIMATE, RELIEF, AND COMPOSITION

Let us now consider some further examples of the landform aspect of habitat but of a different nature. The first is from the western plains, specifically in Queensland, but parallel instances could easily be given from Victoria or New South Wales. At first sight these vast plains are monotonously uniform as regards landforms and it is for this reason as well as climatic ones that grazing properties here have been so huge. But if a look is taken at one such—Bundaleer Plains between Cunnamulla and Goodooga, now subdivided into lots of 40,000 acres—the owners of which are mere 'cockies' in this context—it is seen to have considerable variety of vegetation and soils related to small, subtle differences in the relief. In particular, running from northwest to southeast for tens of miles there is a broad, low ridge of sand, diversified by smaller ridges and swales along its length. It stands out because native pines dominate its vegetation, even though it rises not much more than ten feet above surrounding heavy clay plains which in contrast carry open natural grassland and coolibahs. Present drainage lines such as Widjegoarra Creek are inset into these clay plains. However it is known that such micro-relief and associated deposits in the western plains are the products of former rivers, which it is inferred, behaved very differently from those of today because of a different climate.

The long, low sand ridge represents the watercourse and levees of a 'proto-Warrego' capable of carrying a

LANDFORMS



Because of underground drainage in limestone country, closed depressions in the relief often replace outwardly sloping and draining valleys. Here at 9300 feet in the central highlands of New Guinea is such a closed basin

much coarser load of sediment than the present Warrego brings into southern Queensland. The clay plains to the flanks were built up in floods by the fine-grained overbank deposits of this ancient river. Also there are in the area dunes of wind-blown sand, now fixed by vegetation, and forming other favourite sites for the native pines. So we see that the detailed pattern of habitats in the western plains is inherited from processes fashioning land forms in a past period when climate was different from that now prevailing.

The western plains are alluvial plains in the broad sense, i.e. they are made up of unconsolidated sediments laid down quite recently, geologically speaking, by various agencies, chiefly, of course, rivers. However Australia possesses wide expanses of bedrock plains, where the characteristics of hard rocks may be the governing factors of habitat detail. One of the largest and most distinctive of these bedrock plains is the Nullabor Plain; its distinctiveness stems from the special properties of the limestone making it up. Of all common rocks limestone is the most soluble in natural waters and because of this there is a strong tendency for drainage to go underground through solution channels and for valleys to be disjointed or replaced by closed depressions of various kinds. In keeping with this, valleys are almost but not quite absent from the wide expanse of the Nullabor; the very dry climate also helps to explain the minimal development of relief features through the scarcity of water to perform solution. Nevertheless there is a micro-relief, in parts consisting of parallel rises and swales only five to twenty-five feet different in height. This wave-like pattern is related to the joint systems in the limestone and is due to differential solution of the bedrock.

On the rises soil is shallower and rock crops out here and there; in the swales the surface is completely flat and clay loams form a thicker and complete soil cover. In the coastal belt, where rainfall is highest, the whole plain is covered by mallee scrub but with decreasing rainfall inland, the relief features, small as they are, are often picked out by the vegetation. At first, scrub of mallee, mulga and myall tends to be concentrated in the rises, whereas the flats between are open and carry grass after rains. Farther inland in the treeless plains, the Nullabor proper, there is still variation of the plant cover in relation to the micro-relief; bare clay pans and dark green samphire characterise the depressions whereas grey saltbushes prevail on the rises. What the links between relief and vegetation are is not yet known but they probably operate through soil and moisture relationships.

The drainage, which goes underground in limestone country, produces caves, and the most remarkable surface features of the Nullabor are the big holes due to the collapse of parts of the cave roofs. The walls and floors of these holes provide a different, and in some ways more favourable, habitat, than the general surface of the Nullabor so that they are particularly interesting places for biologists working there. Caves themselves constitute very special, if not bountiful, habitats of considerable interest biologically from the points of view of ecology and of the evolution of species. As yet very little is known of the Nullabor caves from either point of view, but it is interesting to mention that the bats recorded so far from them are not cave—but tree-dwelling in eastern Australia. Perhaps these bats have taken to cave-dwelling in this dry country because of long periods of adverse conditions at the surface.

MORE COMPLEX PATTERNS

The relations between landforms on the one hand and plants, animals, and other aspects of environment on the other are rarely as simple or as one-way as in the examples discussed so far. That the sequence of cause and effect is not always from landforms to soils, thence to plants and lastly to animals was impressed on me many years ago when on an expedition to Jan Mayen, a volcanic island in the Arctic, rather barren and lacking nitrogen in its soils. There is a potential supply of nitrogen in the excreta of the enormous colonies of sea birds there, but these birds live for the most part on sea cliffs which are being actively undercut and any guano soon goes into the sea. However at one point a former sea cliff has been protected from further wave attack by extrusion of a younger lava flow at its foot. This cliff still lies near enough to the sea to be colonised by the sea birds and their excreta enrich the cones of mineral debris below. On these cones is consequently found a herbaceous plant community, which is the richest vegetation found in the island. Landform history provides the frame-

work of the habitat, but the vital soil fertility is furnished by the biological food-chain from the nearby sea.

Indeed organisms may not only contribute to clothing landforms in soil but to the building of landforms themselves. These range from the Great Barrier Reefs over a thousand miles long—the work of coral polyps, calcareous algae and other marine organisms—to the small but exceedingly numerous termitaria of tropical Australia, which imply abstraction from the soil around and reworking of that soil in amounts corresponding to their volume projecting above the ground surface. On coastal sand dunes, the presence of certain kinds of vegetation foreshadows or records the cessation of dune growth and mobility, but other plants such as *Spinifex hirsutus* and the introduced marram grass thrive in fresh sand and promote dune growth by arresting moving sand. In lagoons and estuaries, silts brought in by tidal currents and deposited at slack tide build up the surface to certain levels, that subsequent colonisation by many salt marsh species, or in warmer climates by mangroves, promotes further sedimentation and can build up the accreting surface nearly to high water mark. Thus the geomorphologist is intimately concerned for his own purposes with ecological matters.

INTERFERENCE WITH NATURE

Moreover the geomorphologist has his own special reasons for sharing with naturalists and conservationists in their campaign for nature reserves and wilderness areas. He cannot hope to understand either the present condition or the past history of landforms except on the basis of the natural processes he can observe and measure at work today. However, over most of the earth's surface, the natural conditions of vegetation and soil have been drastically disturbed and so the processes he wants to measure are no longer operating at their natural rate or have changed their very nature through interference. Thus sediment loads of rivers are changed substantially both in nature and amount (they may increase a hundredfold) by clearance and cultivation and so rates of denudation calculated from them are quite artificial. Under certain kinds of forest there may be no surface run-off at all on slopes; once cleared, these slopes may become subject to rain beat and run-offs and their whole form and regime may change as a result. The geomorphologist therefore adds his plea to those of others for the retention in their natural state of samples of as many kinds of habitat with their plant cover and animal denizens as possible. Only with such areas available can the working of natural processes be understood and, by comparison with them, can the effects on geomorphology of human interference with nature be assessed. Without wilderness areas as standards, man's use of land cannot be surely guided into ways which will ensure future productivity. Without them, we shall proceed to our own future detriment, in the words of that great American pioneer of conservation, George Perkins Marsh, 'in ignorant disregard of the laws of nature'.

High up in the Snowy Mountains are ampitheatre-shaped hollows—cirques—which were eroded by small glaciers in a colder climatic period perhaps not much more than ten thousand years ago. The walls of these cirques have been stripped of soil and steepened and have become unfavourable habitats. But melt-water from the snow patches, which last many months, sometimes through the summer, leads to plant growth and peat formation on the lower slopes and floors, which carry a dense herbaceous sward with bright Alpine flowers in summer

PHOTOGRAPHING FROGMOUTHS

by BARRY and JOANNA MORGAN
photographs by the authors

Under the order *Caprimulgiformes* are five families of birds, one being *Podargidae* to which the tawny frogmouth belongs. The 12 species in this family are distributed from Ceylon through India, Burma, Thailand, Malaysia, the Papuan Region, Australia, the Solomons and the Philippines. The tawny frogmouth, *Podargus strigoides*, is found in open woodland throughout Australia and Tasmania. Being nocturnal, frogmouths are not often seen; but with a keen eye they can be noticed during the day on the branch of a tree, posed with excellent camouflage to simulate a dead snag or branch.

Our experience with photographing a nesting pair proved to be interesting as well as a challenge to bird photography. It is no problem photographing the frogmouth sitting on its favourite perch during the day, but trying to get them at night when they are feeding young is another matter. They become active shortly after dusk and like most nocturnal birds are silent in flight. The nest, being a layer of twigs on a thick horizontal branch, was about 12 feet from the ground and a ladder was placed on this branch. With flash and camera I climbed several rungs while Joanna held the torch directed to where we thought the frogmouth might alight with food. After a 30-minute wait the frogmouth suddenly appeared on the branch, but with no warning sound. We missed the chance and by the time the camera was refocused the bird was off again. Another 20-minute wait proved more successful and several photos were taken. This hit and miss system was used for a few hours until we got a good number of shots, and later when the young were larger more variety was added.

Frogmouths can be seen regularly in one area (this pair nested in the same spot for four years and are still there now), enabling anyone with a little patience to compile a worthwhile series of photographs of a most interesting night-bird.

A hard stare convinces this parent that the camera means no harm . . . then on with the job of feeding two hungry young

Eyes half closed, this frogmouth and her young merge into their arborial background

'Action pictures' of frogmouths by day are virtually unknown. But at night many interesting postures and incidents can be recorded

TIME AND THE MARSUPIAL

BY DUNCAN MERRILEES

Marsupials were once far more widely distributed than today. And in Australia there are many species which have long since vanished. The study of fossil remains from the distant past reveals much that is surprising and important, and which may have relevance for our own problems today.

To those who think of the marsupials as characteristically Australian, it sometimes comes as a surprise to hear that several kinds of marsupials flourish at the present time in the Americas. But even some of those well aware of the present-day existence of non-Australian marsupials may still be surprised by the claim that the marsupial 'centre of gravity', so to speak, is not Australian at all if the long geological view be taken.

The earliest known marsupials date back some 100,000,000 years, to upper Cretaceous times in North America. Their presence in France in early Tertiary times is well attested, and their remains are quite widely distributed over South America both in space and in time. On the other hand in Australia they are very little known before the onset of the 'Ice Age', in one phase of which we live today, and which has occupied only the last 2,000,000 years or so. Only those who perhaps understandably, but nevertheless myopically, confine their interests to the present instant of time can think of marsupials as basically Australian. Uncovering the devious ways in which these originally widespread creatures have become concentrated and diversified in Australia in late geological times is a deep and challenging study, and will require the combined efforts of many biological and geological workers in many special fields in many different countries.

Our Australian contribution to this combined study ought to be a major one for the obvious reason that we have unrivalled opportunity to throw light on past marsupials by studying present ones. But in addition we are becoming increasingly aware of the Australian marsupial past, and study of fossil Australian marsupials has received new impetus in recent years.

King Creek on the Darling Downs, Queensland. This is a major location for the fossil remains of marsupials

STANLEY BREEDEN

A fossil jaw of a now-extinct kangaroo (centre, above the pick head) lying embedded in the earth on a bank in King Creek

When this fossil jaw was removed it distintegrated into 11 pieces. A careful reconstruction gave this result

AN IMPORTANT 'FIND'

A 'fossil marsupial' may be an unprepossessing thing to the uninitiated. A recent discovery in Western Australia is illustrated and this specimen will serve to introduce the problems. A first reaction to the photograph shown may be that it just represents a lump of rock. That was all it seemed to some workers in a quarry near Fremantle, W.A. when they blasted it out just before Easter 1965. But after they had delivered the rock to a building site some miles away, the stonemason began dressing it for use in the footings of a house, and he noticed what the reader may have noticed in his second glance. There are teeth projecting from the rock. The mason became interested, reported the occurrence back to the quarry workers, they in turn notified the Western Australian Museum, an examination of the specimen and of the place it came from in the quarry was made, and a new link in the chain of evidence on Ice Age marsupials in Australia was forged. The rock includes part of the skull and lower jaws of a wombat.

To the finders of this specimen (Messrs. P. Masilio, P. and F. Bartolomei and J. Panizza) we owe a debt of gratitude, for they presented their specimen readily and promptly to a public collection worked upon by responsible students. So we come to our next point; not only are 'fossil marsupials' not particularly noticeable, but when they are noticed, they only become meaningful if they are passed into the network of active study. This Fremantle specimen could have remained a mere curiosity, perhaps known only to a few visitors to the quarry office and eventually lost. In fact, it is now assured both of useful and of long existence by incorporation in a properly curated museum collection. And of course, specimens once noticed are only likely to be passed into the scientific network if this is well and widely known to exist; a museum or other research institution must have its public relations in good order.

New finds of fossil marsupials are just as likely to be made accidentally by quarrymen, roadworkers, boring contractors, prospectors, amateur rock hunters, station workers and others as by deliberate search.

THE EVIDENCE FROM FOSSILS

Fossils are not necessarily embedded in rock. This is particularly true of fossils from the most abundant source of all in relatively late geological time, namely cave floor deposits. Cave fossils may just be pieces of bone buried in soft sand or not buried at all. Another illustration shows such a fossil jaw bone from an old cave floor deposit near Strathdownie, western Victoria. It required no special treatment other than brushing off some sand to reveal it as the right lower jaw of a fairly large animal, somewhat reminiscent of a kangaroo, and yet not quite like any existing kangaroo.

This specimen may serve to introduce the next question—how does one know what sort of animal one is dealing with? Anyone can recognize an entire living

Artist's impression of a scene near Mammoth Cave in the south-western part of Western Australia many thousands of years ago. The vegetation is only impressionistic. The marsupials have been reconstructed from information derived from fossil remains; left to right, front—marsupial wolf or tiger (Thylacinus), *'devil'* (Sarcophilus) *and wombats; middle —marsupial lion* (Thylacoleo), *koalas,* Sthenurus, Nototherium (*same family as the largest known marsupial,* Diprotodon). *The aboriginal hunter is included for scale; in fact aborigines may not have reached south-western Australia at the time the Mammoth Cave deposits were laid down*

R. HERBERT

kangaroo as such, but how does one recognize the jawbone of a modern kangaroo as such? And how can one say of a given jaw fragment that it is nearly, but not quite, kangaroo?

It is one of the less well understood functions of a museum to be able to answer questions of this kind, not mainly through its displays, but in having a staff experienced in dealing with the particular kinds of animals concerned, or else in close contact with suitably experienced people in other institutions. The principles are quite simple, but the practice is not.

To identify an isolated piece of jawbone picked up, say, in a cave, depends on having access to a collection of jawbones removed from identifiable carcases, cleaned and suitably labelled for what they are. It is a time-consuming, space-consuming, and therefore money-consuming task to build up a useful reference collection not only of kangaroo jawbones, but of jawbones of all other marsupials likely to be met with, of bones other than jawbones, of mammals other than marsupials, of birds, fish, insects, molluscs and so on through the the animal kingdom. Most of the time and energy of the staff of a museum goes into the building up and study of its reference collections, rather than into setting up displays based on them. With extensive, well documented and closely studied collections to draw upon, informative displays are relatively easy to mount.

With an adequate collection and an adequate library to fall back on, there would be little difficulty in deciding that the Strathdownie jawbone illustrated (a) was a marsupial (b) was related to the kangaroos, but was not like modern kangaroos (c) was a juvenile. Juvenile members of the kangaroo family have a permanent premolar tooth concealed in a crypt within the jawbone, awaiting eruption. This tooth is usually very distinctive in shape and size, and the research worker would probably make a small hole in the side of the jaw and remove it for examination. Even in the absence of other evidence, the structure of this premolar tooth would certainly lead one straight to the next step in the identification. It would show (d) that the animal concerned was of a general kind that had already been recognized and given the (generic) name *Sthenurus*.

But there were once several species of *Sthenurus* just as there are now several species of kangaroos. In this particular case, details of the shape and size of the extracted premolar tooth showed that it did not quite agree with any of the recognized species upon which reports had been published in the scientific periodicals. So it was necessary to describe it and confer a name upon it.

This is not a hypothetical case. Large numbers of specimens were collected a few years ago from an old cave deposit, currently being cut into by a quarry near Strathdownie, Victoria, and were presented to the National Museum of Victoria. A little later, since no staff member in that museum was studying *Sthenurus* at the time, and since someone at the Western Australian Museum was doing so, the Victorian specimens were loaned to the Western Australian Museum. A new species of the genus *Sthenurus* was in fact recognized, a description and name for it have been published within the last few months, and it now takes its place as one of the 'known' species of *Sthenurus*.

Fossil skull of a Diprotodon, *the largest marsupial ever to walk the earth. The head could measure as much as three feet long*

BARRY VENABLES

When this is said, it certainly does not mean that all there is to be known about this species of *Sthenurus* is now known. For example, almost nothing is known of any part of the animal except its skull and lower jaws. Its teeth suggest it may have been kangaroo-like in general bodily build, but this matter is not likely to be settled until some future cave explorer, perhaps, comes upon a skull of this particular kind of animal associated with a skeleton which must belong to that skull and to no other. Usually, one just finds a jumble of skulls and broken bones of many different kinds of animals, and it may not be possible to sort them all out.

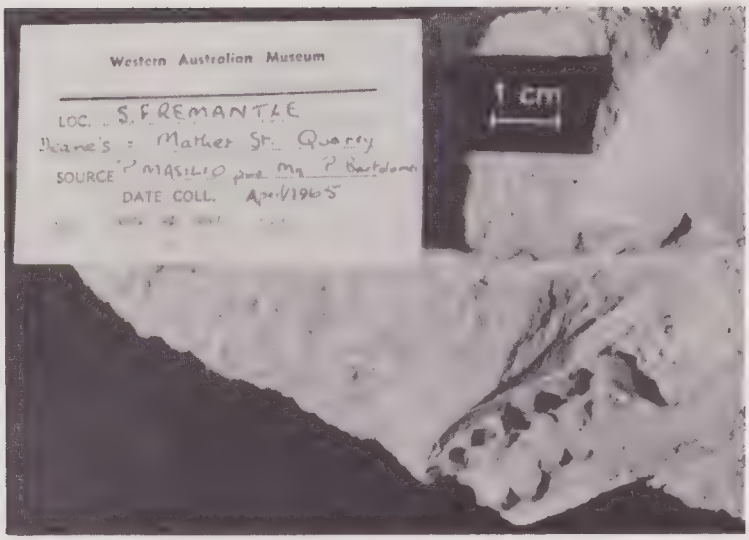
THE PROBLEM OF AGE

With fossils, the question of their age always arises. Occasionally, very occasionally, one gets a direct clue. Such a case has come up recently in the form of a skeleton with mummified skin or flesh adhering to it. It was found in a cave on the Nullabor Plain in 1964 by the Sydney University Speleological Society and has now been presented to the Western Australian Museum. It was at first thought to be the mummified carcase of a dingo, but closer examination showed that it was in fact a thylacine or 'marsupial wolf'. Thylacines had previously been reported from various Western Australian caves, including another cave on the Nullabor Plain. But it had been assumed that the animals concerned dated back many thousands or tens of thousands of years. The presence of mummified tissue on the Nullabor specimen suggests a more recent date, and furthermore, it should be possible to estimate that date within quite narrow limits by measuring the radiocarbon (C14) content of the mummified tissue. Work on this specimen is still in progress.

More often, estimates of the ages of fossils are much less precise. For example, Mammoth Cave, in the south-western corner of Western Australia, long ago yielded a great variety and number of fossil marsupials. Charcoal was subsequently collected from what are

Side view of the lower jaw of Sthenurus gilli *from Strathdownie, western Victoria.* Sthenurus *was a relative of the kangaroos*

W. B. SEWELL



Limestone encloses the fossil bone and tooth. The illustration shows the under surface of one side of a wombat's lower jaws, with part of the palate and some teeth of the upper jaw of the same side. From Fremantle, Western Australia

D. G. GORDON

believed to be the same deposits as yielded the fossils, and this charcoal has been subjected to radiocarbon analysis. But the only information this provided was that the deposit was older than the radiocarbon method was capable at that time of estimating, i.e. older than 37,000 years! It is not yet known how much older; the Mammoth Cave deposits might be 50,000 years old, or 100,000 years or 200,000 years.

UNANSWERED QUESTIONS

With all these difficulties in mind, one can only issue very tentative statements about the course of marsupial history in Australia. But even so, some very surprising facts emerge. Consider the pen drawing, for example. It is an artist's impression of a scene near Mammoth Cave at the (unknown) time when the Mammoth Cave fossil deposits were accumulating, and is based on considerable study of these deposits and of others like them. It is, of course, a rather improbable scene; one would not expect to see so many animals in full daylight so close together, with timid herbivores calmly eyeing predatory carnivores only a few yards away. A more likely scene would comprise one small mammal scuttling away behind a bush in the middle of a dark night. But an artist's impression of this more probable scene might not be very informative! Accepting these improbabilities, the scene otherwise might not at first appear so very remarkable as a Western Australian bush scene. Yet not a single one of the marsupial species represented lives in the area today, and two, perhaps three, of the species do not survive anywhere. Koalas, 'Tasmanian' devils, wombats and possibly thylacines still persist in eastern Australia and Tasmania today. But the lumbering, hippopotamus - like marsupial *Nototherium* (background), the kangaroo - like *Sthenurus* and the 'marsupial lion' (looking out from behind a tree) are everywhere extinct.

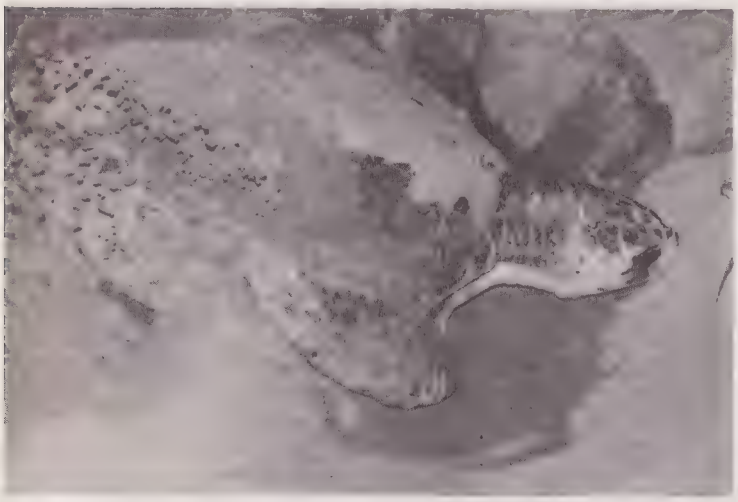
Why did wombats vanish from Western Australia but not from Victoria? Why did thylacines vanish from Victoria but not from Tasmania? What happened to the giant kangaroos, marsupial lions, *Diprotodon* (the largest known marsupial) and others whose fossil remains have been found in such places as Wellington Caves, N.S.W. or Darling Downs, Queensland? (See Wildlife, September 1964 for a note on *Euryzygoma*, one of the most extraordinary of an extraordinary Queensland assemblage.) Perhaps aboriginal man, with his dog and his habit of firing the bush for hunting, was more destructive than is generally believed. Perhaps immigrant men or birds or rats or insects introduced devasting diseases from abroad. Perhaps the Australian climate has been at times harsher as well as at times milder than it is now. We cannot be sure at present because we have too few detailed facts.

But there are some lessons for conservationists from the fossil record even in its present state of incompleteness. One is that extinction of species has always been of frequent occurrence. Western industrial man is only one of many possible dealers of species death. Conversely, western industrial man is certainly himself being acted upon by extinctive agencies of which he may be only dimly aware. Perhaps in this possibility lies one of the most cogent arguments for setting aside large nature reserves and protecting them from human intervention; they may be the cheapest and most effective laboratories for the study of natural processes which may affect the whole future of the human species. Perhaps there is a prospect of practical gain from such apparently unlikely sources as ecology in national parks or palaeontology in caves. Certainly it is easily demonstrable from the fossil record that the strength of a species does not reside in having the most fearsome array of teeth, and perhaps by analogy it may be argued that the strength of a human community does not reside in having the biggest bombs. We do not know precisely where our real strength as the dominant species in the world today lies. An evaluation of this strength may prove to be our most important single task, and it may be that intense study of marsupial history will throw as much light on the human future as on the marsupial past.

The turtle in labor. Mucus streams from the eyes past the powerful beak, capable of crushing bone

THE LONELY STRUGGLE

Text and Photographs by COL. LIMPUS



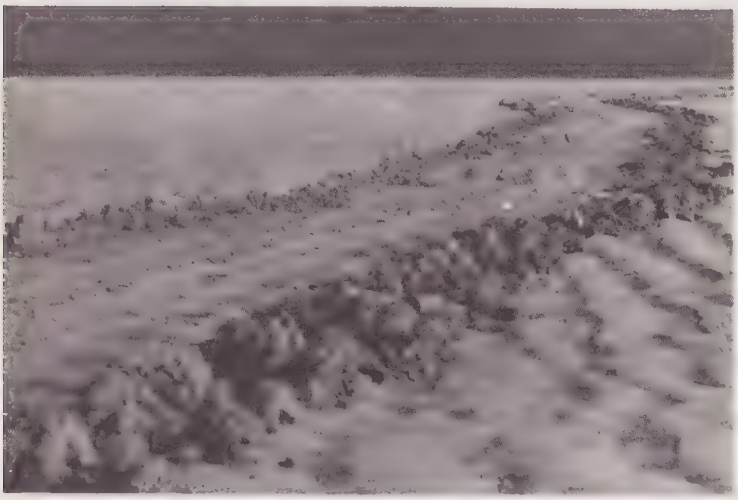
The struggle is nearly over—the turtle carefully covers her eggs before returning to the sea

Each year the female turtle leaves her natural environment to make a difficult and exhausting journey. All along Australia's northern beaches thousands of turtles move from the sea and up the beach to deposit their eggs, a lonely struggle which is often completely wasted as the hatched youngsters fall victim to their numerous eager predators.

Every summer thousands of turtles slowly drag themselves up the beaches of the north Australian coast and adjacent islands. They are green turtles, perhaps measuring some four feet across, and of the species *Chelonia mydas*. And they are all females. For the purpose of this unaccompanied journey is to lay eggs along the high tide mark; but the male, slightly smaller and distinguished by a longer tail, never leaves his aquatic environment.

On the sandy beach the turtle is as cumbersome as she is graceful in the water. She weighs up to 3 cwt. and this weight cannot be supported by her flippers—she has to drag herself over the sand. This laborious journey to the desired nesting spot calls for a tremendous effort and also for several stops along the way. It is only on reaching the level of grass and associated vegetation behind the beach, that the business of nest building begins.

KEITH GILLETT



Heron Island. Two clearly defined sets of tracks are the only signs of the green turtle's nocturnal visit

KEITH GILLETT

The green turtle in its natural habitat —swimming in the crystal clear water of a coral reef

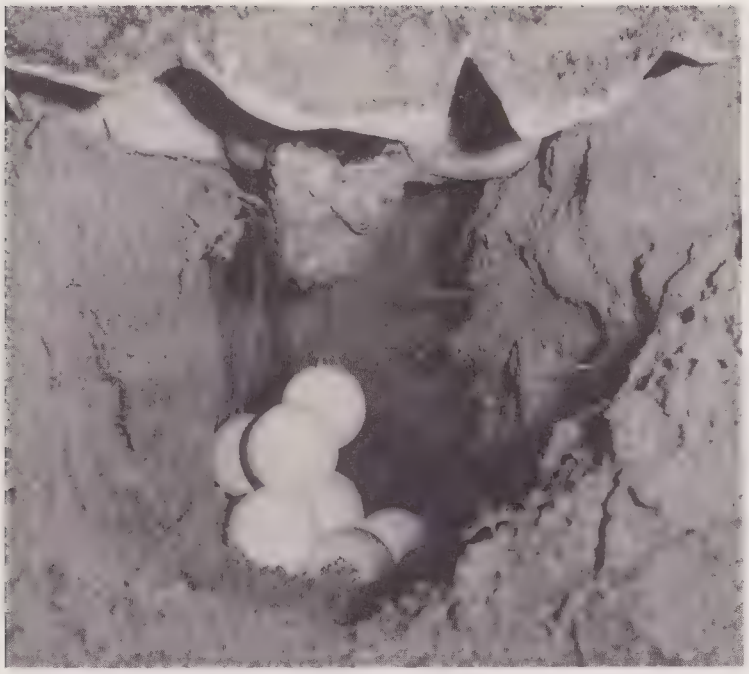
HUNDREDS OF EGGS

The first step is to excavate a small crater. This is done by energetically flinging the sand away with the front flippers. It appears as if the turtle is bogged in the sand and is helplessly trying to get out. After much hard work and frequent periods of rest a depression about four feet long, two feet wide and twelve to eighteen inches deep is dug. Now the hind flippers come into action for the second step. A shaft about nine inches in diameter and to the depth of the hind flipper is dug straight under the tail. To dig this shaft the extended tip of the flipper digs into the sand, the end curls like fingers and the flipper holding the sand is withdrawn. The flippers are used alternately until no more sand can be reached.

Placing the hind flippers on either side of the shaft, the turtle then settles down on to them and the egg-laying begins. At first the eggs come slowly—one or two a minute—but soon the rate increases to about a dozen a minute. Prior to actually laying a group of eggs, the turtle moves her body slightly downwards; with each movement the well lubricated eggs drop into the shaft. The eggs (very similar in shape and size to ping-pong balls) have a white leathery shell which allows them to bounce. The usual number of eggs laid is 150 although the larger turtles lay as many as 200.

If you should ever witness this remarkable event, you must take care to keep noise and lights to a minimum as any disturbance before the eggs are laid can cause her to head back to the sea without laying, so that her struggle up the beach has to be repeated all over again at a later date. But once the eggs are being laid she can be examined closely. By digging carefully, the shaft into which the eggs are laid can be exposed and the eggs can be seen as they drop into the sand. But always remember to keep clear of the turtle's beak as it is quite capable of biting through bone!

When the eggs are laid the depression has to be filled in. Firstly the turtle pushes sand over the eggs with her hind flippers, all the while slowly rocking her body until the sand is tightly packed down. Then she vigorously throws sand backwards with her front flippers. The last part of the operation is accompanied by slow forward movements and in the end the turtle may be four or more feet from the eggs.



This remarkable photograph shows the eggs in the process of being laid into the shaft so painstakingly dug by the turtle

THE NEW GENERATION

The turtle is considerably lighter on her return to the ocean and this trip is accomplished much more quickly. As evidence of her visit she leaves behind two very distinct sets of tracks. In the shallows she pauses for a deep breath, puts her head down and, once again a picture of grace, glides to deep water propelling herself by strong strokes of her flippers. No longer the helpless, defenceless creature she was on land, she will remain in the ocean until the next time she is ready to lay.

The young turtles hatch after nine to ten weeks and begin life by digging out of the sandy nest. Not all of the original 150 eggs hatch, and not all the young turtles that do hatch reach the surface. The weaker suffocate in the sand. But even of those that reach the surface many perish. They still have numerous enemies. As the four-inch youngsters with disproportionately long flippers race over the sand towards the sea, some fall prey to sea birds by day, and others to the silent ghost crabs by night. But some do reach the sea, and again continue the battle for survival. Should they venture from the protection of rocks and coral while seeking small fish to eat, they themselves may be eaten by sharks, cod and other large fish. Only two or three out of each nest ever reach maturity.

KEITH GILLETT

Her task completed, the turtle heads for her aquatic home

All to nought. A silver gull pounces eagerly on the emerging infant turtles

THE RIGHT PLACE No. 1

THE CORROBOREE FROG

Written and Photographed by EDERIC SLATER

Many species of plants and animals are found only in restricted ranges. Others again are associated with a particular habitat even though sometimes found elsewhere. It is the purpose of this series to examine the relationship between wildlife and its typical environment. We begin with an article on Australia's most beautiful frog, uniquely adapted for a unique habitat.

The corroboree frog (*Pseudophryne corroboree*), the most brilliantly coloured species of the genus, can be distinguished from all other Australian frogs by its striking dorsal pattern of logitudinal black and yellow stripes.

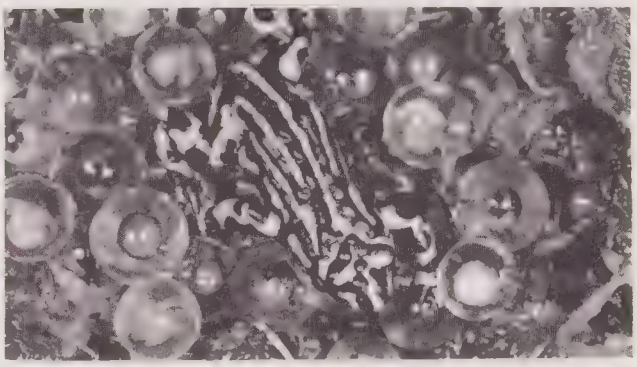
It was described for the first time as recently as 1953 by a visiting American Fulbright Scholar, John A. Moore. At that time the only known specimen was preserved in the Australian Museum; but since the frog's cryptic habitat has become known, many more specimens have been obtained.

The corroboree frog cannot be considered rare, but is restricted in its range. It lives and breeds in burrows in the sphagnum bogs of the Snowy Mountains of southern New South Wales and the high alpine country to the west of the Australian Capital Territory. Little is known of its habits, though it is thought to move away from the snow-covered bogs in the winter months as it is then often found under logs or the bark of trees.

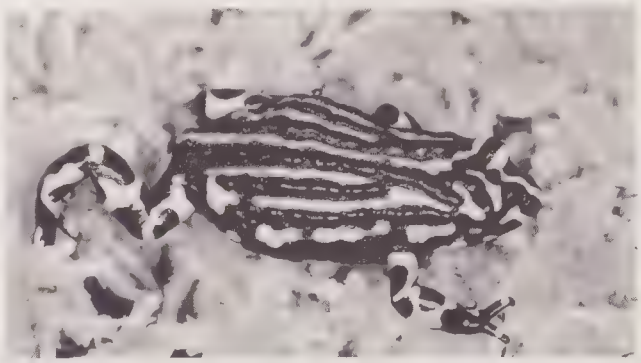
During the months of December to February eggs are laid above water level in chambers in the sphagnum moss. For a small frog about one inch long the eggs seem remarkably large; they are deposited near slowly moving water, never beside swiftly flowing sections of a stream. An interesting adaptation to its moss environment is its method of movement—crawling and burrowing in contrast to the hopping and leaping of most frogs.

The frog has aroused great scientific interest, but only careful preservation of its habitat will ensure its survival. The grazing of cattle and sheep in the high alpine country of south east Australia, burning of the bogs and consequent erosion have all but destroyed its home. The demand for sphagnum moss in horticulture is also a threat.

A sphagnum bog in the Australian Alps—home of our continent's most beautiful frog



A corroboree frog among her eggs. Note the developing tadpoles clearly visible within the eggs



The brilliantly coloured corroboree frog crawls rather than hops

Many of the bogs occur in water catchment areas. They provide a natural regulating mechanism ensuring a constant flow of water from melting snows and rain to the storage dams and turbines of the Snowy Mountains Authority and also to Canberra's water supply. It is in the interest of such necessary engineering schemes to take steps in preserving our few alpine sphagnum bogs in their natural state.

Preservation of these areas will also protect a unique assemblage of alpine plants and animals including Australia's most beautiful and spectacular corroboree frog.

Large eyes and sharp jaws mark the tiger beetle as a fearsome predator

TIGERS AMONGST THE INSECTS

BY BARRY MOORE*,

Illustrated by JOHN GREEN and the author*

*CSIRO Division of Entomology, Canberra

Tiger beetles, as befits their common title, are exclusively carnivorous. Their keen sight, agility and fearsome jaws enable them to detect, run down and dismember their hapless prey with ease; yet they are equally alert to danger, taking to wing at the slightest alarm. Such qualities combine to place them among the most successful hunters of the whole insect community. Some two thousand different kinds are known the world over, and we have about seventy species in Australia. They are most plentiful in the warmer areas of the north; a few reach southwards to Victoria, but Tasmania has none.

The shore near Jervis Bay (N.S.W.). In summer, tiger beetles abound in the zone about high-water mark

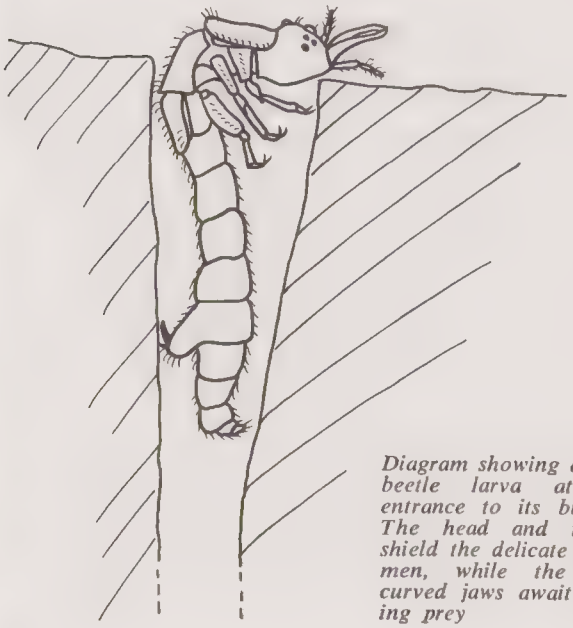


Diagram showing a tiger beetle larva at the entrance to its burrow. The head and thorax shield the delicate abdomen, while the long curved jaws await passing prey

The south coast tiger beetle's white and bronzy-green livery sparkles in the sun, yet forms an effective camouflage against a background of jetsam and sand

The jewel-like green tiger beetle lives along the trashy margins of inland salt-pans

DIVERSE HABITATS

The south coast tiger beetle (*Cicindela ypsilon*) is typical of its kind. In summer this beetle is to be found in countless numbers along the sandy shores of New South Wales. Its handsome ivory-white and bronze-green livery sparkles in the sun, yet forms a very effective camouflage against a background of jetsam and pale sand, from which the insect seldom strays. To even the trained human eye only the occasional movement, or its shadow, gives it away. Take a few steps towards its domain, and the sand suddenly becomes alive with scurrying beetles; press them a little further and they take off with lightning speed. But their flight is seldom sustained for long: a few yards and they drop to the sand, facing the oncomer, once again. Pick a dull day, however, and not one will be seen; all will be in hiding, for these are insects of the sun.

Not all tiger beetles are to be found along the shores: quite a number frequent the rather barren regions of the outback and the North. These are often crepuscular forms that emerge from underground retreats when the sun is low and the mid-day heat has passed. The jewel-like green tiger beetle (*Megacephala australis*) is a good example; it lives along the trashy margins of inland salt-pans, from the Victorian Mallee to the Darling River.

Towards the humid tropics, where thick vegetation closes in and the sandy barrens disappear, tiger beetles take to the trees. In the Queensland coastal ranges several species run up and down the sunlit trunks of peppermint gums, and in the denser rain forests, where all is dim beneath the deep green canopy, still others live in the treetops, flitting daintily from leaf to leaf in search of prey.

THE MAKING OF A TIGER

The larvae of tiger beetles are curious, hunchback creatures that live in burrows, in sand, clay or the branches of trees, according to the species. They have a hard, flat head and thorax, which together form a shield-like cover, to close the burrow and protect the soft hindparts beneath. With only the long, sickle-shaped jaws protruding, the larva awaits the chance arrival of an ant, or other suitable prey, which is drawn into the burrow to be consumed at leisure. Two pairs of stout hooks behind the middle of the larva's back serve as anchors, effectively preventing the creature being dragged from its shelter by its captive's struggles.

The time taken to reach maturity varies widely, according to the vicissitudes of climate and food supply, and it may extend over more than one summer. When fully grown, the larva plugs the entrance and retires to a chamber at the bottom of the burrow to await the coming transformation. Soon a pale white helpless pupa is revealed followed, in a few weeks, by the fully formed adult beetle. A further week must elapse to allow the new integument to harden before the perfect tiger beetle is ready to emerge; but this event may be delayed considerably if unfavourable weather conditions prevail. The beetle may be content to wait for several months before coming to the surface to begin the life-cycle anew.

THE PREHISTORIC LUNGFISH

BY G. C. GRIGG

In the course of time thousands of species have disappeared and others have taken their places. Occasionally, however, forms of a past age survive into a later stage of development. Some survive today and zoologists call them 'living fossils'. One of the most remarkable is the Queensland lungfish, a member of the Dipnoi **group, which reached its peak long before any mammals had made their appearance—in the Carboniferous era—300 million years ago.**

It was in 1870 that science first became aware of a strange animal which inhabited some of Queensland's freshwater streams. It was then described as a 'gigantic amphibian', which was commonly thought to graze and bask on land. Of course no such animal existed, yet the description contained an element of truth. For the creature was the Queensland lungfish, a member of the extraordinary group of fishes which breathe through lungs as well as gills and which are thought to provide an evolutionary link between sea and land dwelling animals.

Of this once widespread group of lungfish, the *Dipnoi*, only three survive today. That found in Queensland is the *Neoceratodus forsteri*. The others are the *Protopterus* from South Africa and *Lepidosiren* from South America. Of these *Neoceratodus* appears to be more primitive than its cousins.

The Queensland lungfish are commonly three to four feet long, heavily built, dark brownish-green above and yellow-orange below, and armoured by large overlapping scales. The paired fins are leaflike and control the direction of swimming while thrust comes from movement of the body and large symmetrical tail. The mouth is small. Large crushing teeth are borne on the palate and lower jaw. The gill chambers are not covered by a bony operculum as they are in most fish. Instead, each gill chamber is covered by a muscular operculum which overlaps slightly the base of the front fin.

Neoceratodus inhabits waterholes in rivers where the channel widens, the water deepens, and flows more slowly. During the day the fish remain on the bottom and can sometimes be seen in the shade of overhanging trees. It is at night that they are mainly active, when they move into shallower waters to feed on the weed banks.

The author looks for lungfish in a pool in the Burnett River near an aptly named railway station — Ceratodus

STANLEY BREEDEN

They are omnivorous, feeding on water weeds, snails, mussels, shrimps, etc. They are even reputed to feed on *Eucalyptus* and *Callistemon* flowers which have dropped onto the water, and the aboriginies are supposed to have speared lungfish after luring them with flowers.

AN 'AMPHIBIOUS' FISH

The lungfish is in no sense a land animal, although its lung undoubtedly contributed to the earlier-held fallacy that it was. In fact the fins are far too weak to support the body on land, and death from dessication follows a few hours' removal from the water unless the fish is kept moist. Several anatomical features are of particular interest. The lung is a singular vascular sac dorsal to the gut, with its air duct leading around the right side of the oesophagus into which it opens ventrally through a slit like glottis. The heart is unusual among fish in having two auricles and partial division of the ventricle. This probably aids the separation of blood returning from the lung (high oxygen level, directed mostly to the head and body) from venous blood from the body (low oxygen level, directed to the lung and/or posterior gills for reoxygenation). This double circulatory pump has evolved separately from that perfected in birds and mammals.

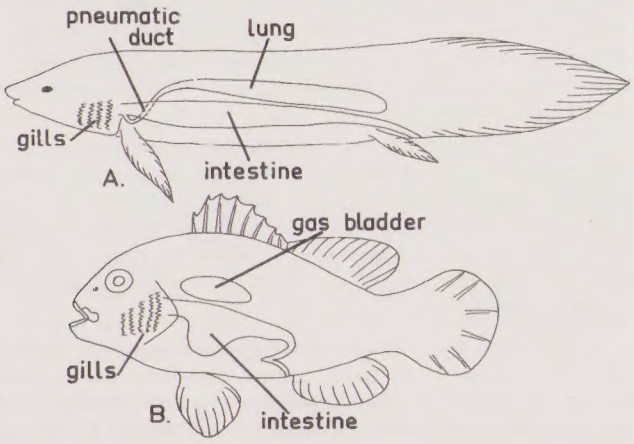
The very name 'lungfish' indicates the remarkable mode of respiration. Gills and a lung are both present. The gills are sufficient to oxygenate the blood at lower levels of oxygen demand, but when the fish are more active (at night, or when they are fighting floodwaters) and have an oxygen demand in excess of that which

can be satisfied by the gills, these are supplemented by the lung. When surfacing for air, the inrush of air often causes a grunting, bubbling sound. This has sometimes been mistaken for vocal ability. Another mistaken idea concerns their ability to burrow. *Neoceratodus* cannot burrow, unlike its relations in South Africa and South America, which do so in order to withstand the drying up of a waterhole.

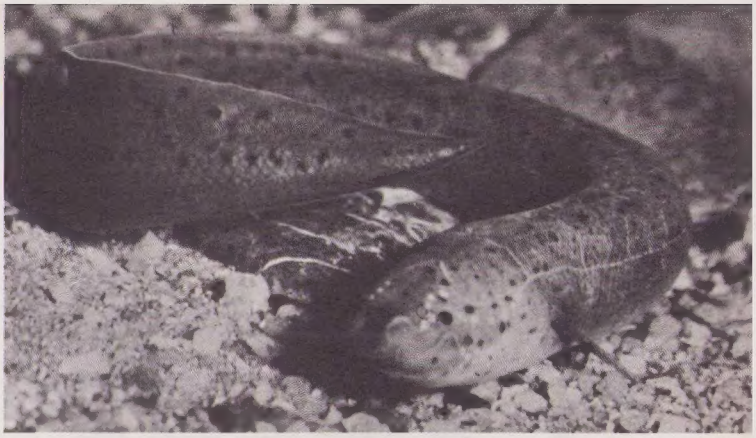
SPAWNING AND THE YOUNG

The breeding season is from August till November. Spawning has been observed by the author on one occasion, when it occurred over a weedbank in about three feet of water—at night. The pair swam about over the bank for some time, selected a site, and the female (presumably) dived repeatedly through the area of weed, frequently shaking her tail rapidly as eggs were laid. In these manoeuvers she was closely followed by the male as he fertilised the eggs. The following morning, eggs were found adhering to the weed in great numbers.

The eggs are each about as large as a small pea, with a dark yolk and nucleus suspended in clear jelly and the whole encapsulated in a transparent envelope. In time the cell divides and grows at the expense of the yolk to form a small elongated embryo, which breaks from the capsule in two or three weeks to begin feeding. Little is known about the food of the larvae but it probably consists of microscopic organisms in the debris on the river bed. The early larvae have no external gills (which are present in the larvae of *Protopterus* and *Lepidosiren*) and are poor swimmers, spending much time lying on their sides on the bottom. The late Dr. T. L. Bancroft from Gayndah reared a number of larvae but had little success in keeping them alive past about twelve weeks — no doubt because a change in diet occurs at this time. Juvenile fish are rarely taken. I know of only a dozen or so under ten inches ever found. Young lungfish probably live under weeds and debris in a very secretive fashion. This would afford them protection, for juveniles would be quite edible by birds, whereas the adult fish would be practically immune to predation because of their size and scaly armour.



Lungfish (A) are able to take up oxygen from water via the gills and from air via the lung. In most fish (B) the gills are the main organ of respiration and the lung has been converted to a gas bladder with no respiratory function and usually without a duct connecting it with the outside. In most fish the gas bladder serves as a 'float'



G. C. GRIGG *The South American lungfish, less primitive than its Queensland cousin*

A CONTRACTING DISTRIBUTION

The distribution of *Neoceratodus* is at present partly artificial. Their range at the time of discovery was restricted to the Mary and Burnett Rivers in Queensland, but in 1895-1896, in fear of the species becoming extinct, a number of fish were transferred to several rivers in southern Queensland and there is now a thriving population in the Brisbane River system. In prehistoric times however, the lungfish's genus was widespread. During the Mesozoic era a genus of fossil *Dipnoi* known as *Ceratodus* was distributed extensively. It was the direct ancestor of *Neoceratodus*, and was rather larger. It is known mainly from fossil teeth, and the distribution of these teeth in Mesozoic sediments indicates that the genus was widespread in Europe, Asia, North Africa, North America and Australia. In Australia, Mesozoic fossils are known from New South Wales, Victoria, South Australia, and Tertiary fossils have been found in Redbank Plains and Darling Downs deposits. Distribution into the Mary-Burnett area must have taken place since the Cretaceous when the Maryborough basin received six thousand feet of marine sediments. Probably the Tertiary distribution in Australia was moderately extensive, and during the Quaternary gradual restriction has occurred, leaving the group to survive in one small area of Queensland and with one representative—*Neoceratodus*.

Among the environmental factors which have brought about this restriction, aridity during ice ages, lack of tolerance to cold, and marine invasions of the land must be high on the list—but one can only guess at the complete complexity of factors and the order in which they have occurred. When more Australian fossils are found and the range in past ages is better understood, it will be of interest to correlate the gradually restricted distribution with what is known of the climates of the time. In the present state of knowledge it seems certain that the ice ages have had a profound effect.

The complete protection of lungfish has been in force for many years, and permits must be obtained for collection for study purposes or export to zoos or museums. This conservation policy is commendable, and the importance of maintaining a thriving population of such a unique fish needs no emphasis. However, occasionally some irresponsible people take advantage of the sluggish nature of the fish and disregard the law by killing them for 'sport', particularly by shooting.

It would indeed be lamentable if a creature able to survive the ravages of aeons of time should fall victim to short-sighted stupidity.

WILDLIFE and the CAMERA

By STANLEY BREEDEN

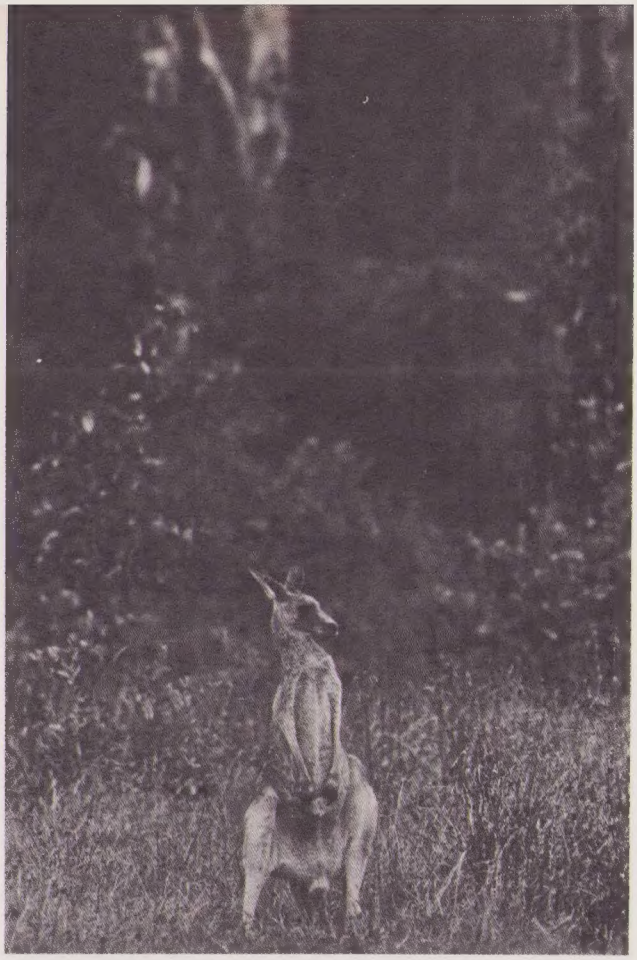
TELEPHOTO AND LONG FOCUS LENSES FOR 35 mm. CAMERAS

There are two kinds of lenses of focal length greater than the standard 50mm. One is the long-focus lens in which the lens to film plane distance is the same as the focal length. In the other, the telephoto, this distance is considerably smaller than the focal length. Both have, of course, the effect of enlarging the subject—the greater the focal length the greater the enlargement. This and other effects can be used to advantage by the wildlife photographer.

Long-focus lenses range from 65-180mm. I find the 135mm. the most versatile and use it for nearly all my close-up work. In conjunction with extension tubes or bellows it gives you greater freedom and better relations with your subject. The reason is that you don't have to come so very close. When, for instance, you are trying to obtain a 1:1 reproduction (when the subject will appear at its natural size on the film) with a standard lens you have to be 3½ inches away with the result that you may well interfere with small and/or hard-to-handle animals while adjusting focus, lens aperture or lighting. For the same reproduction with a 135mm. lens you are three times as far away at 10½ inches. Long-focus lenses also have a narrower angle of view (46° for 50mm. lens and 19° for 135 mm. lens) which means that even in a close-up less background is taken in, meaning less unwanted detail to distract from your main subject. Lighting is, of course, also much easier and more flexible. I always use a tripod when bellows or extension tubes are attached to the camera. If you use your camera with a long-focus lens I would recommend a shutter speed of 1/250 sec. or faster, no matter how steady your hand is.

DRAWBACKS AND MERITS OF THE TELEPHOTO

Telephoto lenses are *not* instant magic. For many facets of natural history photography, lenses of 200 or 400mm. or more are valuable, in a few cases they are even essential. But don't think that now that you have your '400 mil.' you can go and take close-ups of the birds in the tree tops. To obtain a usable transparency or negative of a medium-sized bird, such as a kookaburra, you have to be as close as 25 feet. Also remember that the telephoto lenses select a small area over a long distance when compared with the standard lens, so make sure that a heat-distorted, or dust, or smoke-filled atmosphere does not blur your pictures. Lack of a steady tripod will also cause your picture to lose its sharpness.



The background is brought fully into the photograph by the use of a 400 mil. lens

An advantage of the long focus lens is that effective pictures of venomous snakes (here a yellow-faced whip snake) can be obtained without moving into dangerous proximity

The way telephoto lenses compress perspective can be valuable when trying for animal-habitat shots. You have probably experienced that when taking a photograph of a kangaroo in front of a group of trees, the latter often appear too far away when taken with a standard lens. With a telephoto, the effect is just the opposite, the two combine in a most pleasing way.

Don't be afraid to come close with your 200 or 400 'mil.' If your lens is of good quality, details of feather and fur will be sharp. If used at wide aperture the background will take on a wonderful soft quality—the perfect backdrop for a kangaroo portrait.

I have obtained most pleasure from my telephoto lenses in using them to stalk the larger birds and mammals in the wild. With birds particularly it gives you an opportunity to get away from the stereotyped bird-at-the-nest photographs.

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STOP PRESS

WILDLIFE IN AUSTRALIA is grateful to all our new subscribers and the many hundreds who have written to wish us well. There has been a remarkable response to the Wildlife Preservation Society's venture in publishing this magazine. The press, radio and television have shown a keen interest; the editor has been interviewed on radio and television and items have appeard in several leading newspapers including the Melbourne Age and The Courier-Mail. There has also been a demand for separate publication of individual articles—'Preservation in Perth Park' for the official opening of the native plant section of King's Park, 'Poto Roo' by the Victorian Department of Fisheries and Wildlife, and 'Time and the Marsupial' for the Western Australian Museum.

For all this we are grateful, and feel that our confidence in Australia's concern for conservation is justified. But we still need far more subscriptions in order to improve the quality and widen the scope of our magazine. Subscriptions can be obtained by writing to WILDLIFE IN AUSTRALIA, G.P.O. Box 2030 X, Brisbane, Queensland.

AUSTRALIAN CONSERVATION FOUNDATION ESTABLISHED

At a meeting in Canberra in mid-September the Provisional Council of the Australian Conservation Foundation elected Sir Garfield Barwick as first President, Mr. Francis Ratcliffe Scientific Director, and filled the positions of Treasurer and members of the Executive Committee. The Foundation is now under way, and when its headquarters is established (in Canberra), appeals for membership and for donations towards its first programmes will go out.

Among the first enterprises of the Foundation will be to acquire a special breeding sanctuary or reserve for the Cape Barren goose in the Furneaux Group, and to assist with research surveys aimed at learning more about this rare and threatened bird. Work already done indicates that Chappell Island is one of the most important breeding-grounds. WILDLIFE IN AUSTRALIA will publish an article on the Cape Barren goose shortly, indicating the importance of this programme for its survival.

WILDLIFE IN AUSTRALIA congratulates the Foundation on its inception. We will publish more about its activities in later issues.

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